bertrandt

Bertrandt*magazine*

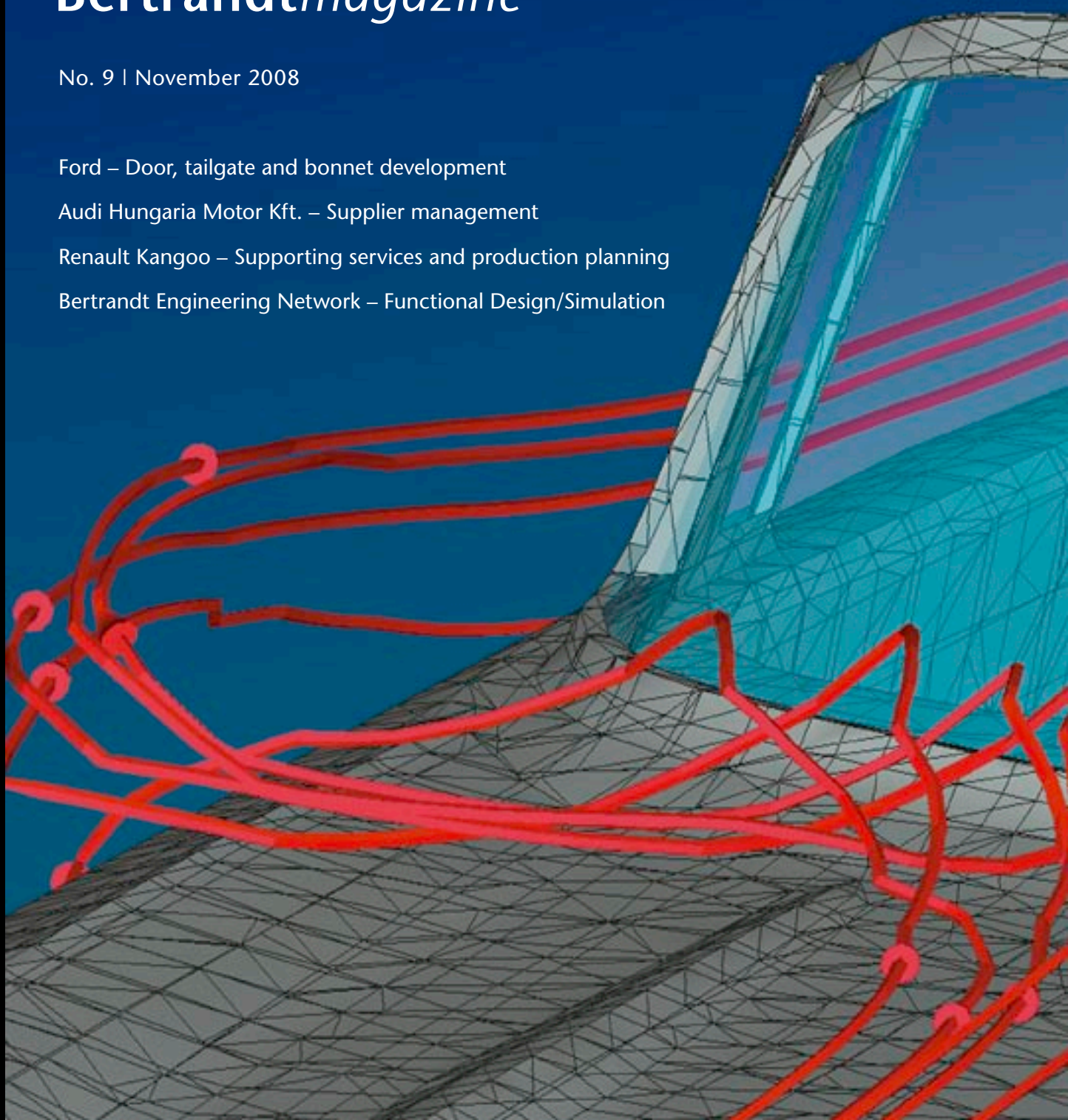
No. 9 | November 2008

Ford – Door, tailgate and bonnet development

Audi Hungaria Motor Kft. – Supplier management

Renault Kangoo – Supporting services and production planning

Bertrandt Engineering Network – Functional Design/Simulation



In this Issue

Editorial

The Automotive and Aerospace industries are dynamic sectors. Modern technologies, new materials and constantly changing legislative and consumer requirements demand high levels of flexibility from the market players.

Against this background, products, development methods and processes have had to be constantly improved and updated, particularly during the last decade. Computer simulations and high-performance computers currently play a major role in improving the timeframes, safety and cost-effectiveness of product development. Virtual representations of components and modules give us an early insight into the world of tomorrow and help engineers to develop forward-looking products. In this context, simulation is an important part of the product development process and puts us on the right course to achieve our functional objectives as efficiently as possible.
In the Bertrandt Functional Design/Simulation Department, the wide range of services on offer and the employees' many years of expertise allow virtual and physical investigations to be combined, which helps the Department to attain its development goals. For our customers, the result is a coherent and robust package of high-quality development services, for components, modules, systems and complete vehicle derivatives. On page 14 you can find out more about our Functional Design/Simulation Department, which aims to provide highly effective support for development projects on the basis of a "best of both worlds" approach.

A kaleidoscope of articles on projects and technical subjects from the Bertrandt world give further insights into the product development process. As a door specialist, quality consultant, project manager or as a user and developer of new methods relating to fundamental trends, including environmentally friendly vehicles or safety and comfort, we are a reliable development partner for future mobility.

Dietmar Bichler

Climb Aboard!

Bertrandt tests doors, tailgates and bonnets for Ford

The Closures department at the Bertrandt site in Cologne has been working in partnership with Ford for almost 15 years. The engineers and technicians in the team have established a reputation with the customer as door specialists. The department's most recent collaborative projects with Ford include the Ford Galaxy, Ford S-MAX and Ford Kuga.

From the start through to volume production

From 2003 to 2005 Bertrandt managed the development of all the doors, bonnets and tailgates for the new Ford Galaxy and Ford S-MAX. A team of around 30 Bertrandt employees in Cologne developed and managed the bonnets, front doors, rear doors and tailgates of both vehicles, from the pre-development phase right through to the release for volume production. Bertrandt employees also worked at Ford on the durability of the doors. This involved virtual testing of the doors for factors such as door sag (static), over-opening (static) and slamming (dynamic). The improvements resulting from these tests were incorporated into the development loops.

New solutions for the Ford Kuga

Bertrandt played a major role in the development of the new Ford Kuga, which was launched on the German market in June 2008. The CAD team working on site at Ford provided support for the conceptual design of the doors, bonnet and tailgate right from the beginning and remained involved until the end, in areas such as welding processes and door surround tests. The Bertrandt team took on a consultancy role after the conceptual design had been produced and the detailed CAD work was outsourced.

A strong team supporting Ford. Around 30 Bertrandt engineers and technicians provide support for the development of doors, bonnets and tailgates for the Ford S-MAX.

Strong team for future generations of vehicles

On each project Bertrandt became involved during the pre-development stage with the Ford closures team. At the end of the concept phase came a transition phase with Ford basic design (R&D), during which the Bertrandt engineers were informed about all the concept ideas and developments. Bertrandt used this as the basis for developing new concept solutions for Ford's planned next generation of vehicles and was able to put innovative ideas into practice in the projects. One example of this is the design of the "tailgate inside a tailgate" concept for the Ford Kuga. This involved developing a plastic tailgate which was integrated into the steel tailgate. During the next phase the focus was on the development processes which led up to the creation of the finished CAD product. Using CATIA V5 and customer-specific development methods Bertrandt produced a complete 3D geometry for each component. Bertrandt provided all the relevant systems with information during the development phase, including the release systems such as WERS, FDVS or AIMS. In addition, Bertrandt provided support for the introduction of CATIA V5 and the PLM system (TCE) at Ford.

Each project was based on the newly introduced Global Product Development System (GPDS) which involved very tight deadlines. Between 50 and 60 Bertrandt employees are currently working in the body closures department at Ford's development centre in Merkenich. These employees collaborate with the Styling-, Craftsmanship-, Vehicle Package-, Manufacturing-, Stamping- and CAE-Departments to develop doors, bonnets and tailgates for Ford models – from the initial concept through to volume production. ■

Laurent Mas, Martin Trefzger, Cologne

Scope of the Ford Galaxy and S-MAX *Projects in Brief*

Doors/Bonnets/Tailgates
- *Pre-Development through to volume production for bonnet, front and rear doors as well as tailgate*

Component testing
- *Durability*

Scope of the Ford Kuga *Project in Brief*

Doors/Bonnet/Tailgate
- *Conceptual Design*

Component Testing
- *Door Surround Tests*

Production Planning
- *Welding Processes*

Developed on the basis of the Global Product Development System (GPDS): the tailgate of the Ford S-MAX.

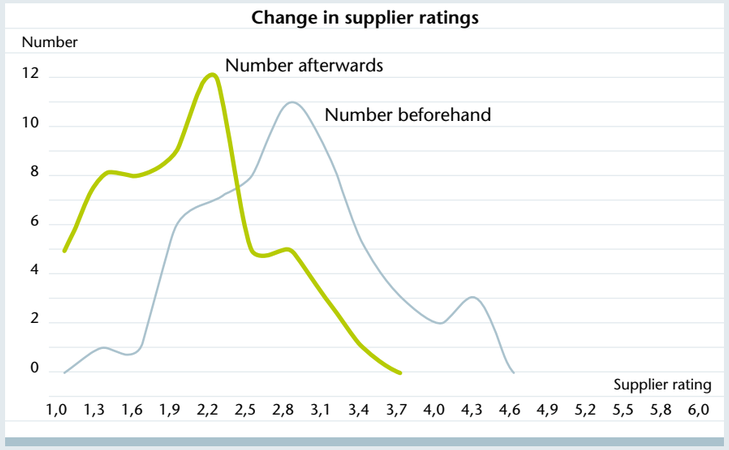
Opening the door to a long-term partnership:
the Ford Mondeo and Cougar lay the foundations, the C-MAX and Focus follow

Bertrandt's Cologne site gained its first experience of developing doors, bonnets and tailgates for Ford as early as 1994. The young team grew quickly, as it impressed Ford on its early projects with its expertise and high levels of quality. Initially Bertrandt was involved with developing the bonnet for the first Mondeo and later with the side doors and tailgate for the Ford Cougar.

As a result of the success of the collaboration, Ford entrusted Bertrandt in Cologne with a further two projects. In the spring of 2000 the development of the Ford C-MAX and Ford Focus began. A team of five Bertrandt employees were responsible for engineering the side doors and tailgates at Ford in Merkenich. Together with Ford engineers, the team worked on the vehicle package, CAE, design, production and sheet metal components. Ford was impressed by Bertrandt's efforts and Bertrandt soon gained a reputation as a door specialist – a reputation the Cologne team still enjoys today.

Quality is the success factor

Supplier management for Audi Hungaria Motor Kft.



Continuous improvement process:
Seven quality management experts worked together with Audi and its suppliers to improve the quality of the complex products even further. The team achieved its goal of increasing the supplier evaluation ratings.

With the aim of improving supplier quality and therefore the quality of products as a whole in the long term, Bertrandt provides support for its customers across international borders with lasting and measurable success. Bertrandt Altenburg was the partner chosen by Audi Hungaria Motor Kft. to implement its zero-fault policy as part of its supplier management programme.

Zero-fault strategy required for premium product

Suppliers are becoming increasingly involved in developing engines as well as entire vehicles. The spectrum of services they offer ranges from subcontracted production to full design responsibility. For this reason, it is essential for manufacturers to involve their suppliers during the development phase and to provide them with regular support at the start of and during the volume production.
Especially for Audi, a premium brand with a sporty image, the engine is the heart of the product. As a result, the company has an explicit zero-fault policy and, in order to meet this requirement, Audi demands the same level of service from its suppliers. Bertrandt helped to ensure that Audi achieved its objective by providing resources and expertise as a project partner.

Process and project audits

In order to identify potential for improvement and possible areas of action, an evaluation of supplier quality was carried out using Audi's quality assurance parts monitoring system (QTS). The resulting data allowed a group of production suppliers to be identified which did not fully meet the quality requirements of Audi and its customers. Bertrandt's task was to improve their performance in measurable ways. For this purpose, the project team, which was structured according to production technologies, carried out a series of process inspections based on process audits (VDA 6.3) and on the qualification programme for new parts (QPN). This allowed for an in-depth analysis and evaluation of the production processes and the identification of weak points and risks. Using this evaluation, Bertrandt worked with the suppliers to draw up improvement measures. Subsequent inspections took place to monitor the implementation of these measures and their effectiveness was ensured by means of regular data comparisons with Audi.

Continuous evaluation improves supplier quality

A supplier evaluation system was set up which was able to distinguish between all the different types of complaints. This enabled the status at the start of the project and any improvements during the course of the project to be identified. There was a specific emphasis on the faults which occurred during the later phases of the value added chain, as these are particularly costly to rectify and involve internal clients or end customers. In addition to this data, which can be measured objectively, the quality specialists on the project team also considered subjective factors, such as cooperation, the effectiveness of measures and the ability to innovate, and included these in the rating which the supplier received.
Bertrandt's objective was to reduce the "parts per million" (ppm) by 50 percent during the course of the project and therefore to cut the number of reject parts produced by all suppliers by half. In addition, the aim was for each supplier's rating to increase by one point.

Subsequent commission confirms the success of the project

The project was awarded to Bertrandt's Altenburg site, which took responsibility for managing and coordinating it over a period of nine months. The project team consisted of seven Bertrandt quality specialists with experience of process and product audits and the relevant manufacturing technology, together with a number of Audi employees from the QA Bought-in Parts G/GQ-3 department. The project team held two or three process inspections for each supplier. Reports were submitted to Audi each week concerning the results of these inspections and the measures that had been specified. In addition, the Bertrandt employees sent the plant Quality Management and Bought-in Parts Quality Management teams monthly project status reports. This information was used as the basis to formulate the strategy for follow-up visits.
Bertrandt was responsible for managing the reporting tools, including a data sheet showing supplier performance and a tool for evaluating the entire project in detail. The project was successfully completed in mid-2007.
As a result of the measurable and lasting success of the project, it was extended when Audi Hungaria Motor placed a follow-up order at the end of 2007. During the six-month period, the aim was to evaluate and develop the preventative quality measures. The focus in this case was on project start-ups, new suppliers, essential components and critical processes. ■

Daniel Elschner, Altenburg

Audi Hungaria Motor Kft.

In the Hungarian city of Györ around two million engines for Audi and the VW group come off the production line every year. The spectrum ranges from the 1.6 litre petrol engine, which is manufactured using a highly automated, volume production process, to special 10-cylinder engines.

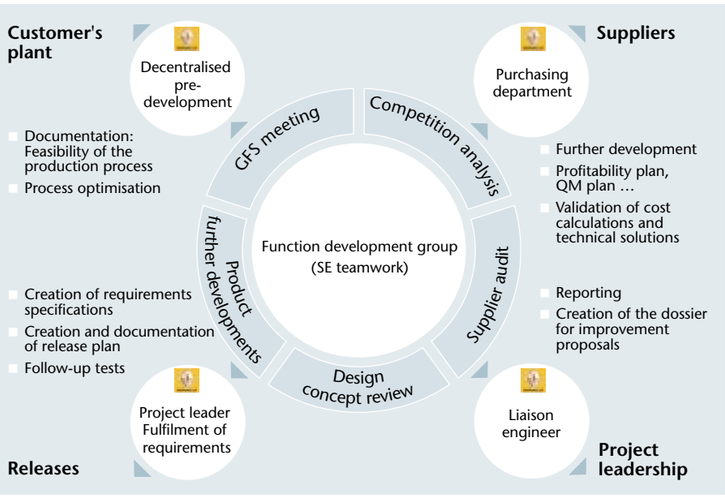
Scope of the Audi Hungaria Motor supplier management *Project in Brief*

Quality management
- *Auditing*
- *Project-based quality management*

Supplier management
- *Supplier support*
- *Complaint management*

Functional and Comfortable

The new Renault Kangoo



Responsibilities of the Function Development Group.

Scope of the Renault Kangoo Doors *Project in Brief*

Production Planning

- *Optimisation of the manufacturing process*
- *Method planning*

Supporting Services

- *Quality management*
- *Competition, cost and quality analysis*
- *Documentation*
- *Project management*
- *Suppler management*

Bertrandt also enjoys a good reputation in France due to its high level of expertise. For this reason, the development service provider was chosen by Renault as a competence partner to supply components for the new Kangoo and to develop and provide series support for vehicle derivatives in the functional area of seals and glazing.

Experienced partner for a modern car

When the Renault Kangoo was launched ten years ago, it signified a revolution in the van segment. As an innovative "Fun Utility Vehicle", the car not only offered exceptional variability but also featured a practical space concept with a high utility value. But above all, the special feature of the Kangoo was its design concept: at extremely attractive prices, it could be ordered in many different configurations, including – for the first time in this vehicle segment – with a side sliding door.
The new Kangoo is even more practical and more comfortable than its predecessor. It combines the functionality of a small van with the comfort of a car. Within the framework of a project order, Bertrandt proved to be a highly experienced partner in the development of the door equipment.

Great responsibility – good solutions

The project covered three different scopes in the area of door development. For the seals/glazing and door mechanics components, Bertrandt was responsible for project management, supplier support and design. Furthermore, the team was responsible to Renault's project management for complying with the quality, cost and scheduling requirements. The third functional area included the door architecture, which involved embedding these components into the overall architecture of the vehicle (dimensioning and environment). The main task of the project leader was to manage and coordinate the various development departments such as body-in-white or trim. The aim was to achieve a harmonious whole on the basis of the requirement specifications and process specifications.
The special requirements for this vehicle type with regard to costs, versions and cycle time were among the challenges mastered by the Bertrandt team.

Demanding requirements

As an all-rounder, the Kangoo comes in a variety of different versions: without, with one or with two sliding doors, optionally with folding or retractable windows, as a small van with twin rear doors or with a rear tailgate.
As a result, the Bertrandt developers had to consider various window, seal and locking versions – including a number of special versions in the passenger car segment such as twin rear doors or side sliding doors.
At the MCA Maubeuge assembly plant on the Belgian border, the two generations of the Renault Kangoo were produced on a single assembly line until July 2008. Therefore, variant management, the amount of space available along the line and the simplification of the processes were already to be included in the design concept and implemented at start of production.

The Function Development Group

The Function Development Group is a unit that is responsible for the development and implementation of a given functional area or project scope. It consists of a team leader, various sub-project leaders and designers.
Their responsibilities:

- Developing a release plan
- Securing and complying with legal regulations and standards
- Follow-up for quality, cost and scheduling specifications
- Development of a quality management plan for the project and the process
- Follow-up for the design and further development of parts on the basis of the requirement specifications
- Alignment of requirement specifications with quality, cost and scheduling specifications as well as the submission of improvement potentials
- Regular reporting on the achievement of targets to the project manager

Bertrandt meets expectations

The project leader for the overall architecture was required to develop technical definitions that meet the quality, cost and performance objectives in accordance with the overall objectives of the customer. By direct integration into the customer structures, Bertrandt was able to immediately adopt, supplement and bring together the requirements of the function, process and performance experts. This enabled them to achieve good solutions that met all expectations.

The project phases in detail

The beginning of the assignment was the start of production for the vehicle at the assembly plant. Accordingly, Bertrandt supported the series launch, ensured follow-up for the releases by customers and suppliers and implemented the customer's QM plan. In spite of the short learning period, the Bertrandt team was continuously present at the customer's design office as well as in the factory and at the suppliers, and, due to its great commitment, was able to fulfil the customer's requirements within the given schedule.
With the market launch of the vehicle, the range of responsibilities was extended by the addition of a further task. In cooperation with Renault, the Bertrandt developers initiated a continuous improvement process in order to adapt the manufacturing process to the constantly expanding product range and to optimise costs. In discussions on competition analysis and supplier audits as well as technical discussions on the various function areas, the engineers and technicians were able to contribute numerous analyses and proposals for further developments in cooperation with the teams from Renault.
In accordance with the specifications to ensure the widest possible product range and the best possible quality, the start of production for the different vehicle types took place in different batches. In this case, the task lay in the parallel further development of series production and the successive start of production of the various derivatives. Here too, Bertrandt was able to fulfil the requirements in cooperation with Renault's utility vehicle subsidiary IDVU.

Success along the line

Project management and execution under their own responsibility, the integration of several competence centres, implementation at the Bièvres plant and compliance with contractually agreed targets were among the tasks that the Bertrandt team mastered with extreme competence.
In this highly demanding project, the engineers and technicians successfully showed their project management skills and technical expertise, thus demonstrating the wide range of services provided by the engineering service provider in module and body development. ■

Angel Moran, Paris

The new generation

Development support for the infotainment system for the Ford Kuga

Networking audio storage media with the navigation system.

User-friendly and clearly arranged: Browser showing iPod- and telephone-screen.

The start of volume production of the Ford Kuga also heralds the launch of a new generation of entertainment and infotainment systems. The advanced "Sound & Connect" package allows a portable MP3 player to be connected to the car's audio system via a 3.5 mm stereo jack and USB port. Several Bertrandt engineers provided support for the development and integration of the new system working in close cooperation with the relevant departments at Ford.

Controlled via the audio system

The new voice control system in the Ford Kuga allows drivers to concentrate fully on the road. They use simple spoken commands to operate the audio system, the air conditioning and the mobile phone, via wireless Bluetooth® connection, without having to take their hands off the wheel.

A new USB port provides additional features. It can be used to connect a portable MP3 player to the audio system via a 3.5 mm stereo jack (AUX socket). This allows USB storage media and Apple iPods® to be operated with the audio system controls.

Finding your way around

The innovative Ford system, for which Bertrandt provided development support, allows car owners to display the complete file structure on the display and control unit of the radio or navigation system. Using the voice recognition system, it is possible to access special playlists or folders. The system has the same familiar categories (playlists, artists, albums, songs, genres and shuffle) as the iPod. The emphasis during the development process was on ensuring that car owners have a familiar user interface in their vehicles.

Voice control for mobile phones

A Bluetooth® interface enables mobile phones to be operated via the audio system or the multifunction steering wheel. The phone itself can be left in the driver's jacket pocket or handbag. Depending on the phone model, it is also possible to display a list of missed and received calls and dialled numbers.

High-quality sound reproduction and the latest navigation systems

The different entertainment and information systems also provide very high-quality sound. Even the entry level model has an output of 4 x 20 watts.

Two modern navigation systems will keep drivers on the right track. The top-of-the-range NX model, with DVD support, is operated using a 7-inch colour LCD touch screen, which also controls the audio and air conditioning systems. Customers also have the option of the lower-cost Blaupunkt TravelPilot FX model, which comes with a 5-inch colour display. Both navigation systems are MP3 compatible and can be combined with a 6-CD changer.

Bertrandt's expertise

Bertrandt's engineers worked on site on the development and integration of the new generation of Ford infotainment systems in close collaboration with the Ford development departments. Bertrandt's development support services covered all the phases of the project, including requirements management, functional integration, system integration, verification and validation right through to the final launch. Bertrandt was also involved in project coordination, systems supplier management and coordination with vehicle manufacturing and customer services. ■

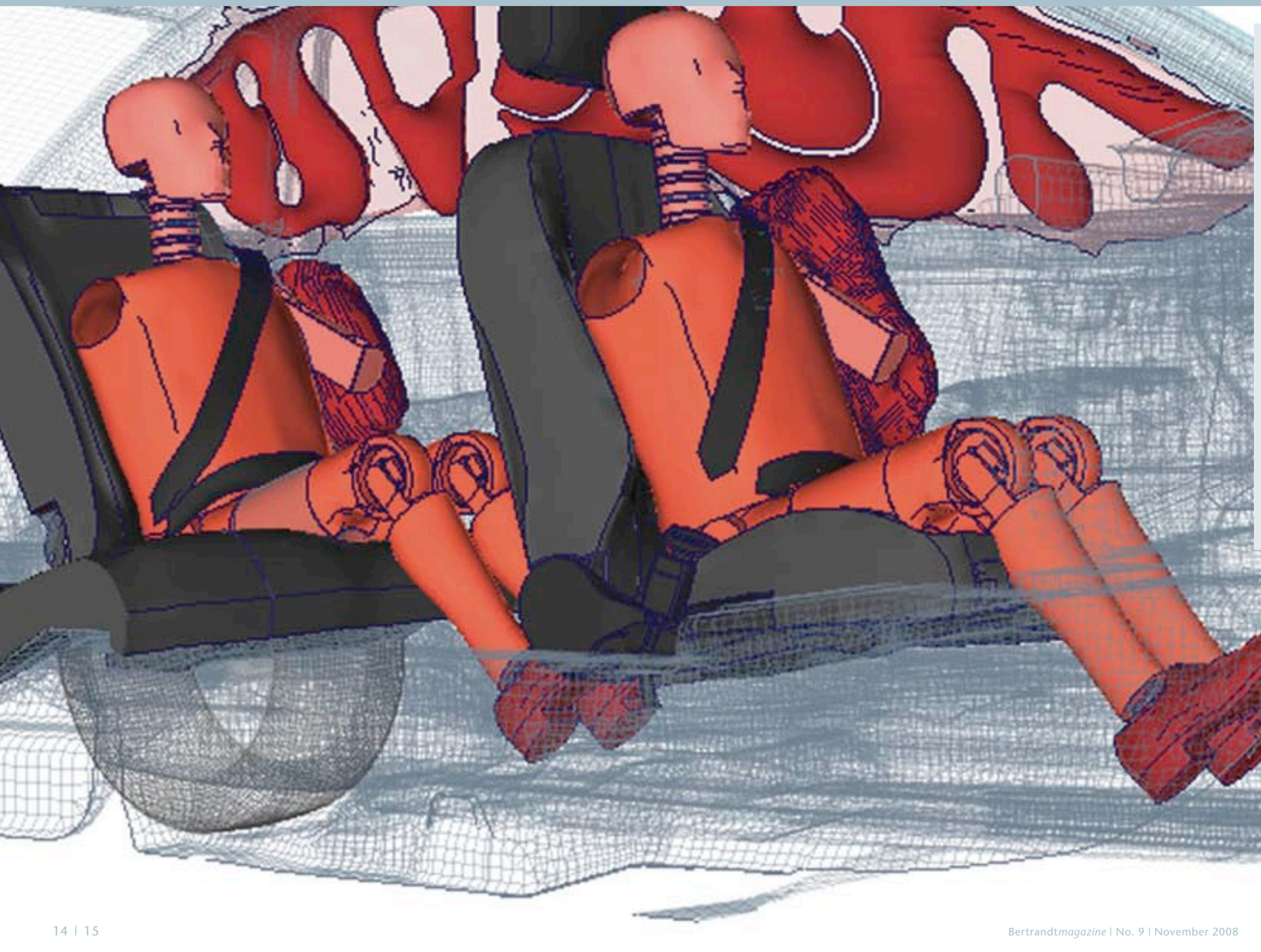
Thilo Hecht, Cologne

Scope of the Ford Kuga Infotainment Development *Project in Brief*

Electrics/Electronics

- *Requirements management*
- *Functional and system integration*
- *Specification*
- *Supplier management*
- *Verification and validation*
- *Project coordination*
- *Launch support*

Functional Design/ Simulation (CAE)



The global nature of competition has resulted in enterprises being forced to improve quality and cut development and production times. For many companies, computer simulations are an essential part of their efforts to respond to these pressures on time and costs. “Simulation is playing an increasingly important role in the development process,” explains Hans-Gerd Claus, Engineering Director of the CAE department at Bertrandt. He and his team use up-to-the-minute methods during the early stages of development to define the functions of components, modules and complete systems. In addition, the appropriate use of virtual and physical technologies is opening up new opportunities for designing and testing vehicle functions – in order to meet the latest legislative requirements, for example. In this context, simulation is a decisive factor in product development because it lays the foundations for success at an early stage.

The best of both worlds

As one of the key factors in reducing development times and costs, simulation also offers the potential for accelerating processes even further in the future, while keeping costs to a minimum. The combination of simulation and testing helps that the best possible results can be achieved. “By making systematic use of the best methods available in both the virtual and the physical worlds we can be as effective and as efficient as possible,” says Hans-Gerd Claus. He believes that the major strength of his department lies in the wide variety of services it can provide. Alongside expertise in simulation, Bertrandt employees also have extensive product knowledge. Their skills help to improve efficiency and to increase the added value that the company can offer its customers, as well as providing the basis for the successful development of individual products from functional perspectives, such as safety, comfort or service life.

“A simulation model is a representation of specific real-life functions.”

“We are dedicated to the virtually driven development with robust accomplishment of functional goals.“ Hans-Gerd Claus, the Engineering Director of the Functional Design and Simulation Department at Bertrandt, has very clear ideas about how the Department should be run. The Department consists of more than 100 developers with over 10 years’ experience of providing Simulation Services to international customers of the Bertrandt group from the Automotive and Aerospace Industries. Simulation is an essential part of the development process and therefore has a decisive influence on the successful implementation of innovative ideas. In this interview with Hans-Gerd Claus, we discuss the potential, the customer benefits and the complexity of his department.

B*m*: Mister Claus, what benefits can Simulation bring in the product development process?

Hans-Gerd Claus: Our customers all take very different approaches to product development, but the one factor which they have in common is the pressure on time and on costs. Decisions about product design must be made in increasingly short timeframes and for this reason it is essential to ensure before tool release that no serious problems arise during the subsequent testing phase. These so-called virtual releases based on simulations take place in advance and ensure that volume production can start on time.

B*m*: What are the crucial success factors for Simulation?

Hans-Gerd Claus: In the automotive development process, the successful use of Functional Design and Simulation depends on a number of different factors. Because of the global nature of development, we currently work with advanced hardware and software which allows us to create highly complex virtual models. In addition, Simulation has become significantly more important over recent years. It now forms an essential part of the development process and this was not always the case. This leads us to the final important factor, which is that the designers clearly recognise the benefits of the active use of Simulation. The added value that it offers helps to motivate the team and to increase productivity.

> “Functional development projects would be impossible without the use of simulation.”

B*m*: How has Bertrandt adapted to the increasing importance of this area?

Hans-Gerd Claus: Bertrandt identified the potential of this segment and its positive reciprocal effects on other areas of development at an early stage. Therefore, the company actively supported the expansion of the departments in the individual sites and across the whole group. Nowadays functional development projects of the kind which take place at almost all our sites would be impossible without the use of functional design and simulation.

B*m*: As the intensity of development projects increases, they are also becoming more complex. Which challenges are developers faced with in this respect?

Hans-Gerd Claus: No one disputes the fact that it is not currently possible to represent every physical process effectively in virtual form. We come up against a wall in the case of certain processes, such as the fracture behaviour of plastics. For this reason, it is important to define clearly in advance the functions that will be simulated in our models and the functional objectives of the development process. There are fundamental differences between testing the crash behaviour and the heat transfer behaviour of a vehicle using a model. What it comes down to is that a simulation model is a representation of specific real-life functions. As the level of detail increases, our main challenge is to make the right assumptions.

B*m*: How do your specialists ensure that the level of complexity remains manageable?

Hans-Gerd Claus: The comprehensive expertise of our engineers is what guarantees the success of our projects. A mixture of sound, in-depth knowledge of vehicles, development and simulation, and consistent quality management are the keys to our success and form the foundations for the high levels of quality and added value that we can offer in the development process.

B*m*: What is the main benefit for customers?

Hans-Gerd Claus: Our contribution within Bertrandt goes far beyond status analyses and reports. The real added value of Simulation is the consultancy that we provide to the relevant departments during the development process. As we focus on achieving specific objectives as effectively as possible, our expert interpretations of the simulations allow us to provide developers with valuable information as a basis for decision-making.

> “The added value of Simulation is the consultancy that we provide during development.”

B*m*: How important is your collaboration with the testing department?

Hans-Gerd Claus: Because it is not possible to effectively represent all the relevant functions using Simulation or to develop a complete vehicle in a virtual environment, the collaboration between Simulation and testing is becoming increasingly important. The basic principles of Physics mean that this is unlikely to change in the foreseeable future. The close cooperation between the two departments, which varies depending on the individual function in question, allows us to make use of synergies and therefore to achieve the best possible results.

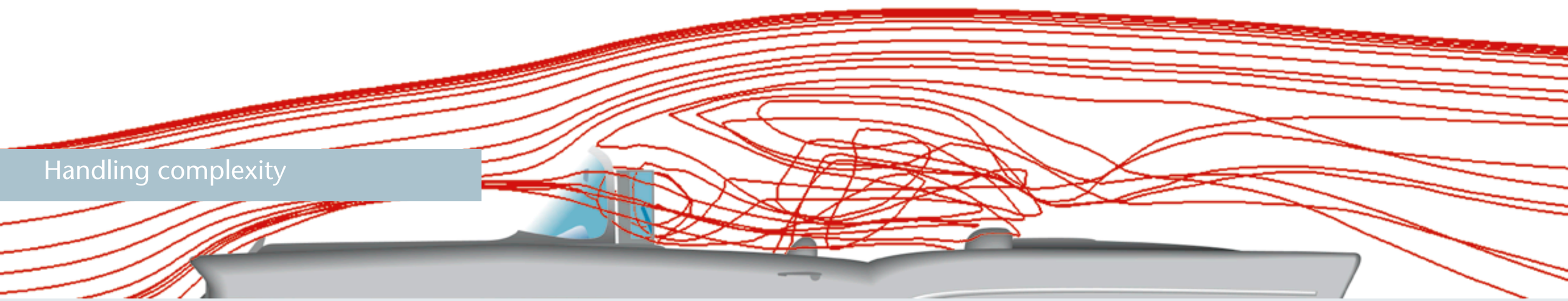
B*m*: What is your department’s greatest strength?

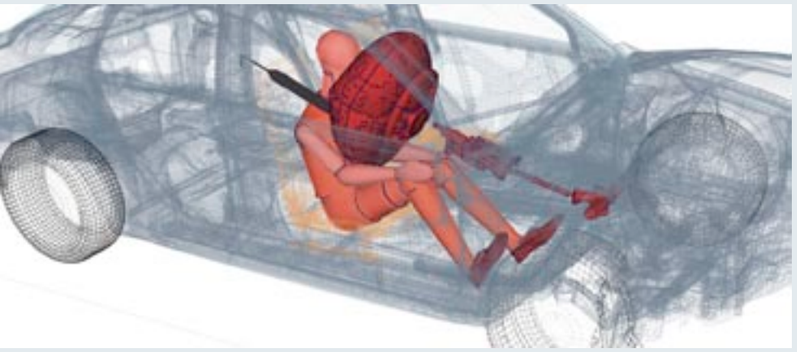
Hans-Gerd Claus: The skills of our team members, which include expertise in Simulation and extensive knowledge of modules and vehicles, distinguish us from the competition. This allows us to provide in-depth support for projects in the form of status reporting and specific, viable proposals for improvements.

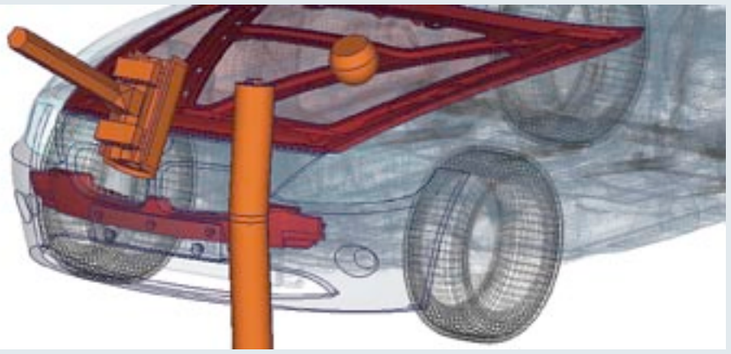
B*m*: Where is the department heading?

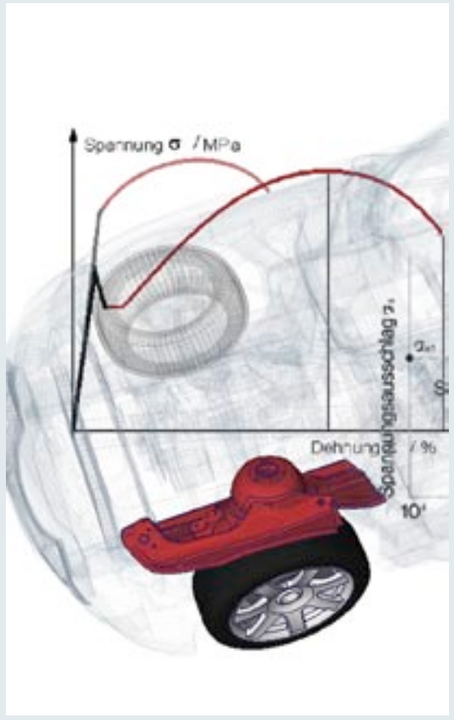
Hans-Gerd Claus: Ongoing improvements to simulation tools are opening up new possibilities for the development process. For example, our department will benefit from the increased use of stochastics. Investigations into the entire range of tolerances will allow us to produce figures that cover the overall possible range of results. This will enable us to identify the worst-case combinations of parameters at an early stage and to take the necessary measures to produce robust designs. ■

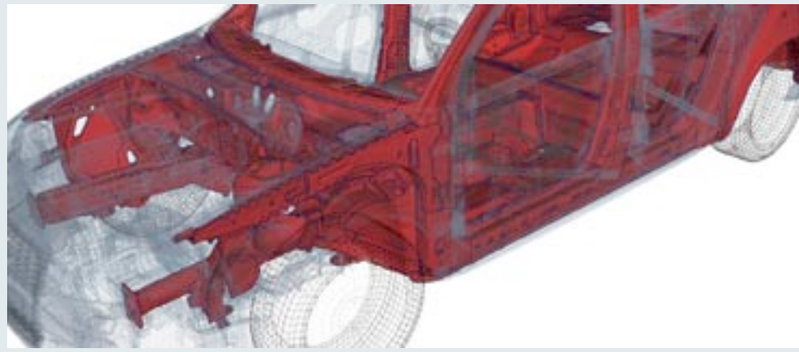
Handling complexity

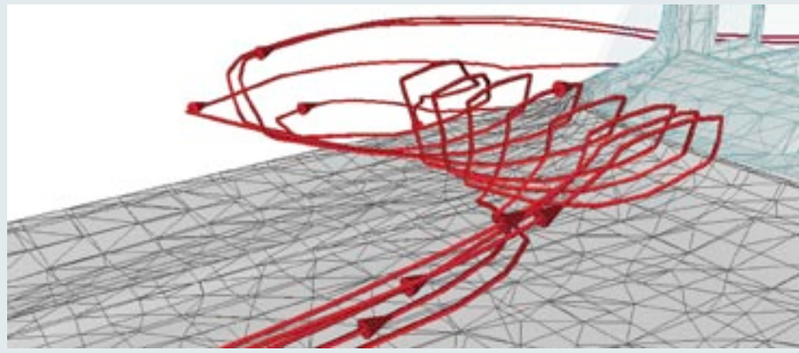












Passive and Active Safety

As more electronic systems are integrated into vehicles, an increasing amount of information about the current status of the vehicle and its situation throughout the accident escalation path is available. A number of different functions can be used to increase the safety of the occupants. The range of functions available is extensive, including warning messages from the vehicle, reducing energy before impact using automatic braking and automatically adjusting the seats to the safest position immediately before collision. In some cases these functions can result in an accident being avoided altogether. The combination of Active and Passive Vehicle Safety has resulted in the development of new areas of simulation in which Bertrandt plays a strong role.

Occupants Safety

Simulations concerning occupant protection focus on the complex behaviour of the entire vehicle and therefore take into account all the safety-related components. These include the vehicle body and interior modules, such as the seats and the cockpit, but also restraints, such as the safety belt, belt tensioner and airbags. The occupants can only be given the best possible protection by ensuring that all these individual elements are effectively coordinated.
The protection of other road users, in particular pedestrians, is also an important issue. One aspect of this involves designing the front of the vehicle so that injuries to pedestrians are kept to a minimum in the case of a collision.

Stiffness/Vibration Comfort

New vehicles have to meet increasingly high standards of comfort. The virtual design of the static and dynamic stiffness characteristics forms the basis for meeting these standards. The characteristics are measured throughout the entire vehicle body, in individual components and in particular at sensitive interfaces, such as that between the body and the chassis.

Service life/structural durability

The stresses to which individual components and modules throughout the vehicle are subjected during their planned service life can now be represented using modern simulation methods. These take into account both the components themselves and the joining technology used.

Designing the body structure

The focus here is on a harmonious overall design for the bodywork and a functional balance across all the target values. Bertrandt provides support for this process in the following areas of simulation:

- Body structure crashes (high and low speed)
- Stiffness and vibration analyses
- Service life/structural durability (component and joining method)

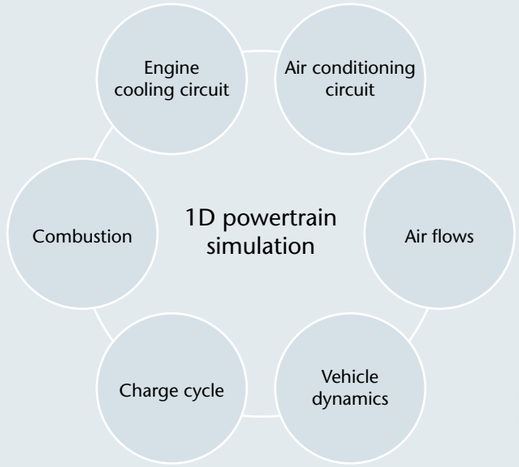
Computational Fluid Dynamics

The efficiency of high-performance engines depends on a variety of different parameters. On the one hand, the circulation and flow of media are crucial to the performance and efficiency of engines. On the other hand, virtual methods can be used to evaluate components of the cooling system, drag coefficients and consumption. Complex models are created to simulate aerodynamics and engine cooling systems.
When it comes to comfort, the emphasis is on comprehensive simulations of air conditioning, heating and cooling in the interior of the vehicle. However, it is also important to take detailed issues into account, such as windscreen de-icing or the flow of air over the occupants of the vehicle.

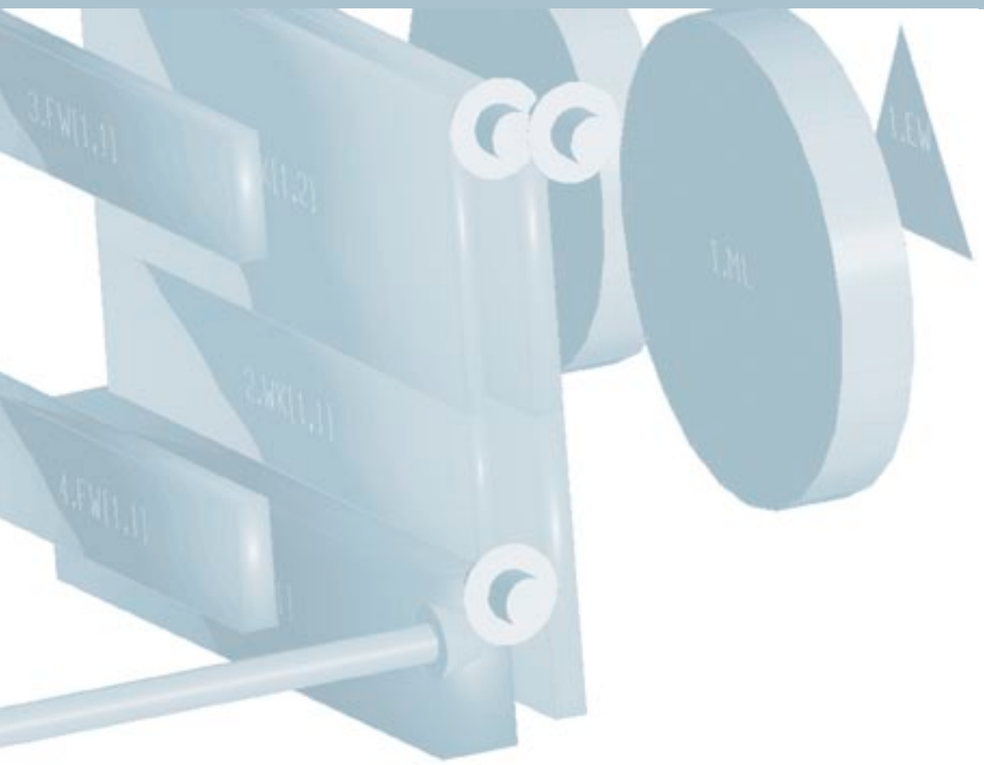
The rapid alternative to CFD

One-dimensional flow simulation of thermodynamic circuits

One-dimensional flow simulation



Use of 1D simulation at Bertrandt.



Simulation plays an important role throughout the entire product development process. Particularly in engine development it can give insights into flow relationships which are otherwise difficult or impossible to measure. Compute-intensive 3D simulations are generally used to predict trends, but 1D tools, which require less computing power, represent an interesting alternative and can produce similarly useful results for specific applications.

3D versus 1D

3D CFD (computational fluid dynamics) is compute-intensive because of its spatial resolution in three dimensions. This applies in particular to the simulation of engine internal flows, where very fine meshes must be used for discretisation in order to achieve the appropriate level of accuracy. Computing times of several hours, for example, to simulate a one degree crank angle, are normal even on high-performance clusters. It is difficult to predict at the moment whether these computing times can be reduced significantly in the near future. Currently all available computing resources are being invested in increasing the complexity of models and the geometric resolution. 1D simulation represents a useful alternative solution, as it uses less complex, one-dimensional or quasi-dimensional relationships. As a result, 1D applications make it possible to carry out a rapid assessment of influential parameters or to create comprehensive operating maps of different components.

1D simulation at Bertrandt

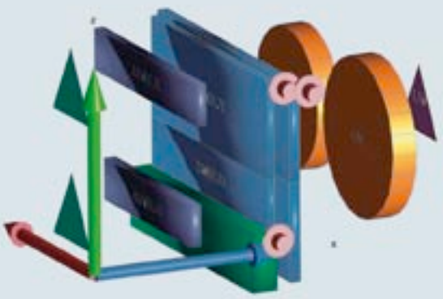
1D flow simulation is making an important contribution to the skills development process in the powertrain department, by allowing team members to develop powertrain functions independently. This complex simulation method, which nevertheless uses very little computing power, allows different scenarios or solutions to be compared with one another quickly. This gives engineers an important basis for decision-making about the development of components. The 1D simulation process is used primarily for the engine cooling system, the air conditioning circuit, the interior air conditioning, the combustion process and the analysis of complete systems. The following three examples indicate the variety of possible applications.

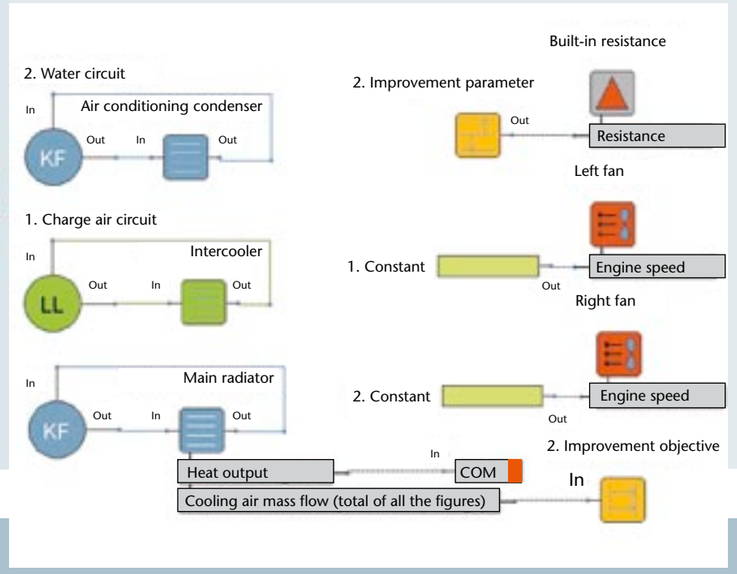
Simulating coolant and refrigerant circuits

Against the background of current efforts to reduce emissions of greenhouse gases (for example, by cutting consumption and introducing CO_2 as a refrigerant), 1D tools are becoming increasingly important in the development of air-conditioning circuits. Originally, Flowmaster software was used to simulate all the aspects of the engine cooling system, the engine compartment flows and the air flow for the interior air conditioning. In order to produce a broader picture of the engine cooling system, the Kuli software package was added to the mix, which is specifically designed for engine cooling in vehicles. Bertrandt also uses Dymola, a powerful tool for designing air conditioning systems, which comes with an air conditioning library.

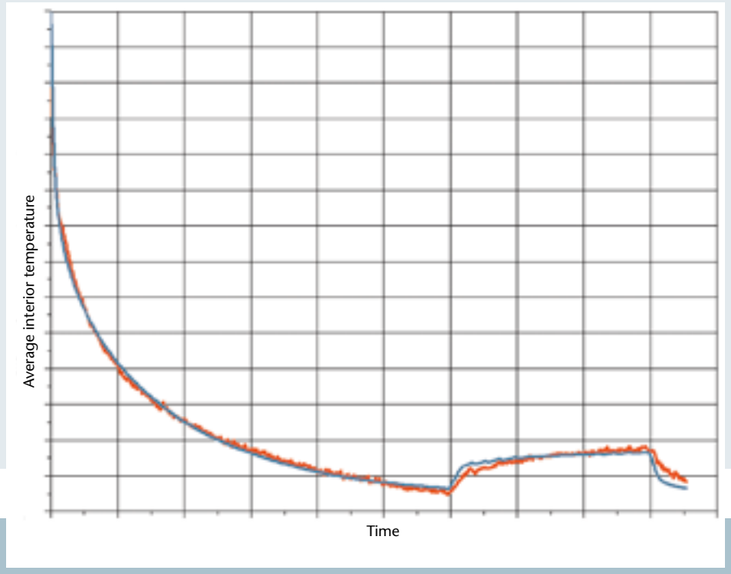
The combination of the different tools allows a broad spectrum of 1D flow simulation services to be offered in the areas of engine cooling and air conditioning to provide support for the development process. These services include:

- Developing and adapting component models
- Creating and managing air and refrigerant circuits
- Stationary and transient simulations
- Sensitivity analyses and optimisation
- Concept development
- Further development of the simulation methods





3D view of a front-end consisting of an intercooler, air conditioning condenser and main radiator and the corresponding network in Kuli.



Simulation of the average temperature of the interior of a car.
Top axis: Measured and simulated average interior temperature, standardised.
Bottom axis: Absolute deviation between measurement and simulation.
(Degree dissertation by Maik Nitzsche, Bertrandt Ingolstadt.)

Analysis of an entire system to improve the energy flow

The Bertrandt group's expertise is growing as a result of more advanced activities and, in particular, internal projects – such as "Energy and the Environment in the Drive Train". The objective of this project is to develop intelligent and efficient drive train concepts, taking into account factors such as emissions, costs, cost-effectiveness, safety and driving pleasure. In order to be able to compare the proposed solutions objectively, a tool has been created which simulates the energy chain throughout the entire drive train in MatLab/Simulink. The abstract base model contains no physical sub-models. Instead the behaviour of the sub-models is described in terms of characteristic curves and figures. Energy flows (in other words, engine speed and torque, current and voltage) are used to allow the models to communicate with one another. The tool has been validated using the test bench measurements from a specific vehicle and the results are highly consistent with the official figures. The advanced base model has sufficient functionality to represent complex drive train configurations and it is now possible to optimise different concepts in the energy flow and compare them with one another. Several variants, such as micro and mild hybrids, which use only brake energy recovery or a small electric motor for pulling away, have already been implemented and investigated in the model. Further variants will be added, including serial hybrids, in which a generator produces electricity that charges the battery and powers an electric motor which moves the vehicle. Investigations into improving control strategies, hybridising the ancillary units and other options are also being carried out in parallel.

Evaluating the potential of direct LPG injection

However, simulation techniques are not only being used to support the process of developing engine peripherals and the entire drive train. They are also helping to develop skills in simulating engine internal flows after the initial groundwork has been carried out.
As part of a degree dissertation, the potential of direct LPG injection (liquefied petroleum gas) in a petrol engine was investigated with the aim of reducing CO_2 emissions. A two-zone model created in Matlab simulated the internal thermodynamics of the engine and a correlation was used to calculate the ignition dwell time. This allowed a compression ratio to be identified at which the ignition dwell times of LPG/air and petrol air mixtures were the same. Based on the assumption that different mixtures have the same ignition conditions, this model allows the compression ratio to be increased and the resulting potential reduction in fuel consumption to be evaluated. However, the model cannot simulate the gas exchange dynamics. There are also no predictive models available which can simulate the energy released by the combustion process or the reaction kinetic methods in order to determine the composition of the combustion gas.

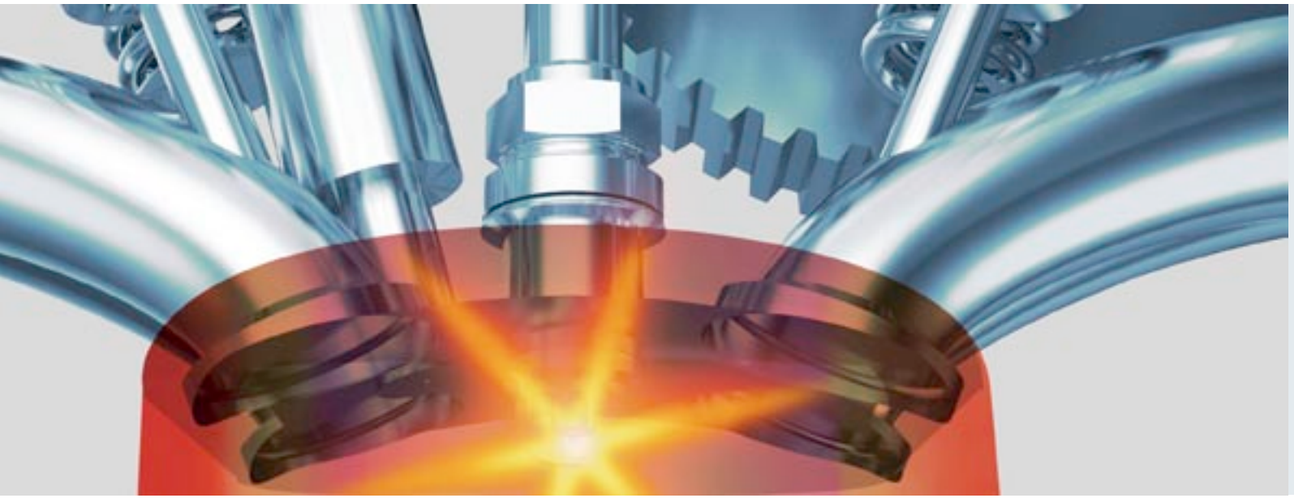
Final step: Engine thermodynamics and integration

The objective is to be able to evaluate the thermo-fluid dynamic processes throughout the entire drive train using 1D simulations. Bertrandt is currently testing additional tools for charge cycle and combustion simulation for this purpose. Once a network of highly specialised applications for the individual areas of 1D flow simulation has been established, the tools will be linked together via a central communication platform. This will allow a complete virtual representation of the drive train to be created. The Matlab/Simulink tool described above will act as a modular integration platform for combining existing features and adding new ones. ■

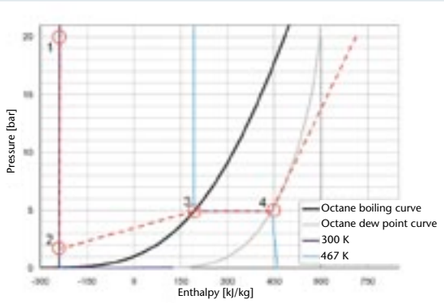
Stefan Djuranec, Matthias Rühl, Ingolstadt

Thermodynamically sensible

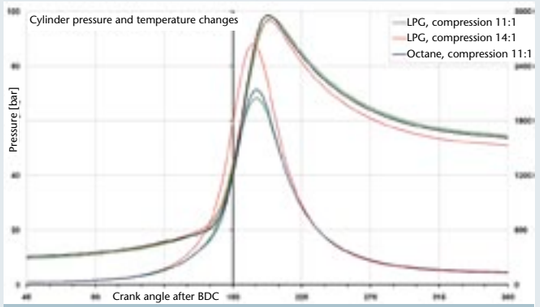
Direct LPG injection as an option for environmentally friendly engine design



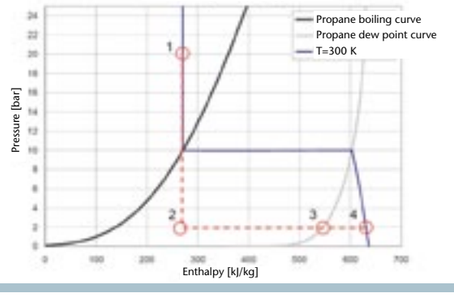
P-h diagram for octane.



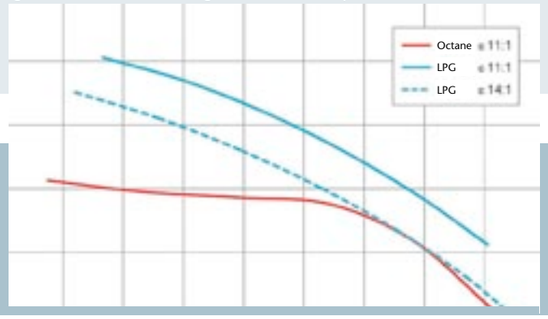
Graph showing pressure and temperature changes.



P-h diagram for propane.



Ignition dwell times during the combustion process.



Environmentally friendly mobility is one of the challenges currently facing the automotive industry and improvements to the internal combustion engine will make a significant contribution in future to achieving this objective. The focus on the development of the combustion process will continue, which is why engine process simulation is becoming increasingly important for Bertrandt's Powertrain department. Basic groundwork has been carried out in various areas to increase the department's expertise and the potential of individual measures for reducing pollution and CO_2 emissions has been evaluated.

Background: The thermodynamic potential of a direct injection LPG engine

LPG or liquefied petroleum gas has a number of advantages as an alternative fuel for petrol engines, including excellent vaporisation properties, a relatively low proportion of carbon and high knock resistance (approximately 110 octane). A fundamental study was carried out to evaluate the thermodynamic potential of the fuel using direct injection. The main benefit of this is the option of internal cooling. The low knocking tendency allows the compression ratio and therefore the efficiency of the engine to be increased.

Against this background, a process simulation was used to investigate a direct injection LPG engine. The objective was to quantify the increase in the efficiency of the entire engine and the reduction in CO_2 emissions caused by lowering consumption and decarbonisation.

Model structure and sequence of events

The engine process, including the charge cycle and high pressure injection system, was represented in a MatLab model, which shows the indicated brake mean effective pressure (BMEP), the efficiency and the development of the state variables, such as pressure and temperature, in the combustion chamber. The piston diameter and stroke were used to indicate the size of the engine. In addition, the design of the ports was specified. This allowed the charge cycle to be simulated by specifying the pressures before the inlet valve and after the exhaust valve. The study did not include the gas dynamics in the intake and exhaust systems.

In the high pressure injection system, compression and relaxation were simulated using real gas behaviour. The combustion process was described by means of the Vibe function, taking into account the longer-lasting combustion of LPG. During the heat input phase, a simplified two-zone model was used to show the development of the state variables in the zone where combustion had not taken place. In addition, the model also took into account wall heat transfer and fuel vaporisation.

Vaporisation process and knocking tendency

Initially the vaporisation process was investigated in detail, with the vaporisation times and enthalpy of vaporisation being of particular interest. As expected, the vaporisation times of LPG were particularly good. A simplified approach using the D2 law showed that the vaporisation rate of LPG was significantly lower than that of the octane.

The differences were smaller in the case of vaporisation enthalpy. Although the enthalpy is higher in the case of LPG, it can only be partially used. During the injection process the fuel pressure is reduced to that of the cylinder. As a result, LPG moves into the two-phase area, which is why it cools rapidly and partially vaporises. Therefore, the enthalpy of vaporisation can only be applied to the part of the fuel which remains in liquid form. The major temperature difference between the fuel and the environment in the cylinder accelerates the heat transfer, which explains the rapid vaporisation of LPG.

Comparison of ignition dwell times

Finally, the cold fuel vapour must be heated to cylinder temperature, taking additional heat from the air in the cylinder. As a result, the total cooling is slightly greater than during the vaporisation of petrol. In the model, the required energy was determined on the basis of the injection or vaporisation time and therefore took into account the current state of the cylinder.

The most important issue was the change in the knocking tendency. It was assumed that there is a similar relationship between the knocking tendency and the ignition dwell time for the different fuel-air mixtures. As a result, the ignition dwell times were identified using the current values for pressure and temperature in the zone where combustion had not taken place – and compared with one another. After this, the compression ratio and ignition dwell time for LPG were modified to bring the results nearer to those for the octane.

Model simulation confirms the benefits of LPG

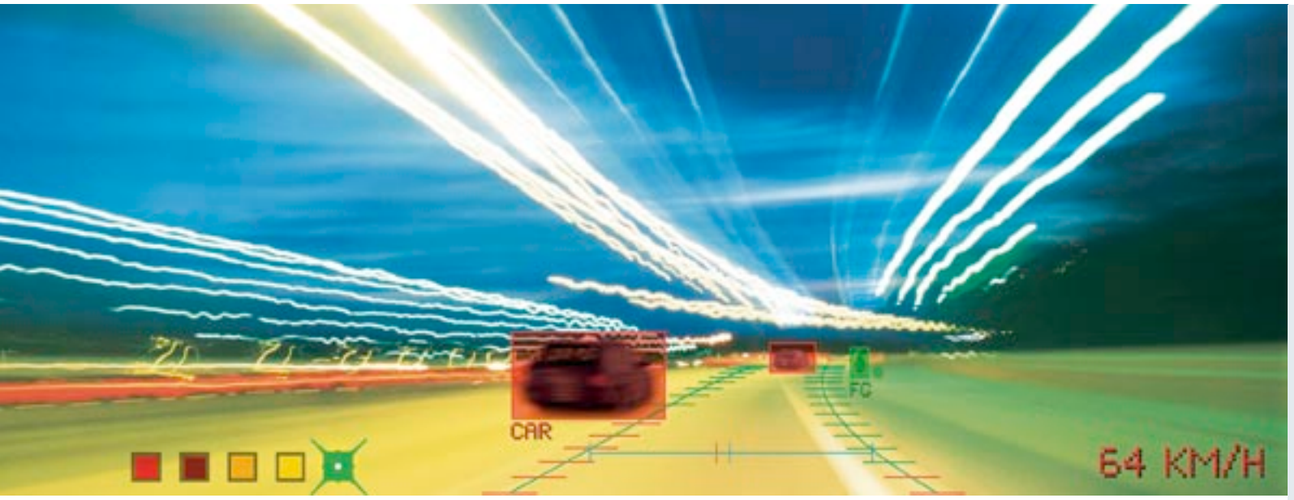
The simulation confirmed the expected advantages of LPG. Under identical conditions, such as internal BMEP, compression ratio, position of the central combustion zone and injection starting point, LPG had a significantly lower knocking tendency. Compared with a petrol engine with direct injection and a compression ratio of 11:1, if the position of the central combustion zone is identical and designed for optimum efficiency and if the ignition dwell times are similar, the compression ratio can be increased to around 14:1. The internal efficiency of the process increases by 5 percent and the consumption falls accordingly. The CO_2 emissions are around 14 percent lower (decarbonisation). In conclusion, it is clear that the homogeneous direct injection of LPG makes sense in thermodynamic terms. The known benefits of direct petrol injection can be transferred to LPG. The mixture is a less critical factor, which means that it is possible to be more flexible in specifying the injection time than it is with conventional petrol engines.

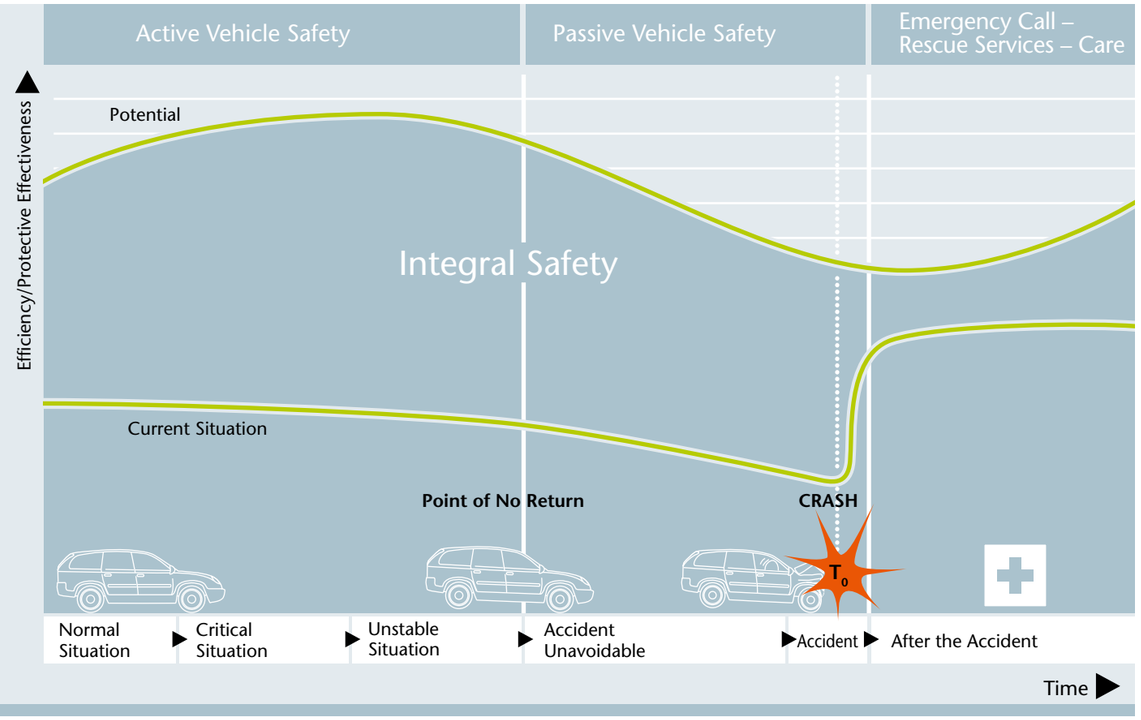
The issue of the influences on modern combustion processes remains unresolved. A charge stratification is one of the more critical considerations among the basic conditions. In order to prevent the jet of fuel from being released too early and the cloud of fuel from being blown away, the period between the start of the injection process and ignition must be made even shorter than in petrol engines. Further simulation and testing is needed to determine the extent to which this is possible and would produce the desired results. ■

Raphael Jacob, Sven Wolf, Matthias Rühl, Ingolstadt

Integral safety

Combining active and passive vehicle safety





In its 2001 White Book, the European Union set itself the goal of reducing the number of road deaths by 50 percent by 2010. As a result, development activities in the field of vehicle safety have increased in intensity over recent years, with the consequence that the latest car models offer their occupants a high level of protection. Future industry plans to improve the safety of road users are presenting OEMs, suppliers and development service providers with further challenges, which many are aiming to meet through close collaboration.

Advanced development of protective meassures

"Passive Safety" involves measures aimed at minimising the consequences of accidents and limiting damage. The purpose of "Active Safety" is to allow accidents to be avoided and to reduce the frequency with which they occur. These two areas, together with all the aspects of the rescue services' activities, combine to make up "Integral Safety". The Integral Safety approach aims to evaluate the effectiveness of protective measures throughout the entire accident escalation process and to develop the most efficient measures further, in order to increase the potential protection for all road users in the long-term.

The developers' job is to bring together active and passive safety for vehicles and to consider the two concepts as a whole. Current areas of development include identifying hazardous situations at an early stage during normal driving and simultaneously interpreting them. This will result in measures being introduced in both the active and passive safety systems.

"Integral safety" development platform

Many developments, such as advanced comfort and driver assistance systems, reversible restraint measures which can also be conditioned, automatic emergency call systems following accidents (e-call systems) or new materials and their composites have already been introduced by the majority of OEMs. Each of these individual modules and systems increases the potential protection available for drivers and passengers.

The "Integral Safety" development platform is created by linking together active and passive vehicle safety measures with assistance and comfort systems and the functions which come into effect after an accident.

Providing support and improving performance

Modern driver assistance systems not only support the driver while the car is in motion, but also improve the performance of the entire network consisting of the person, the vehicle and the environment. Using new sources of information and new means of presenting the information, the driver can enter the route he wishes to take and stabilise the situation by making targeted interventions. In addition, assistance systems are able to intervene in critical situations. In everyday circumstances, they can also partially take over the task of driving the car.

The data which these systems need is provided by a large number of sensors in the vehicle. The data is processed in the vehicle's control units and passed on to the relevant control systems. However, there is still potential for improving the protection available for occupants. Developers are working on increasing the quality and quantity of the information which the sensors provide, using appropriate algorithms to transmit the data clearly and at the same time combining it with active and passive safety systems.

More complex test systems

The challenges which integral vehicle safety presents to OEMs, suppliers and development service providers include ensuring the effectiveness of the linked systems. For example, if information from driver assistance systems is fed into the design process of passive safety equipment, not only is more extensive testing needed, but new types of test scenarios must also be developed. In order to ensure that the systems will function perfectly in every possible situation in which the vehicle may find itself in normal operation, the subsystems (sensors, algorithms or actuators) must be tested separately and in combination with the entire system as a whole.

The environment and circumstances such as weather, lighting and road design, together with the condition of the driver's own vehicle and those of other road users, must also be taken into account during the tests. As it is not possible to cover every possible road situation, the automotive industry is in the process of developing standardised test scenarios which represent realistically what can happen on the road.

One important area is the behaviour of drivers, who may use the new safety systems in different ways or react differently to the information that they provide.

Ensuring that systems function correctly

The fundamental purpose of the tests which have been developed is to ensure that the systems function correctly and to minimise risks caused by misuse or misinterpretation of the systems and system failures. Bertrandt is already working on possible test scenarios and on standardising them. The company is in contact with and collaborating with OEMs and a number of suppliers and will be working even more closely with them in future. With its broad range of services and the network covering all of its sites, Bertrandt is ideally positioned to provide the automotive industry with support in the new areas of integral vehicle safety by taking a forward-looking approach to meeting its customers' needs. ■

Andree Hündling, Jan Christopher Kolb, Ingolstadt

Everything under one roof!

Bertrandt establishes an electronics competence centre in Ingolstadt

Complex test systems, e. g. the FlexRay network tester.

Robots testing infotainment-components.

Development and testing of electrical systems on laboratory test benches.

At the Bertrandt site in Ingolstadt all electronics specialists are now working under one roof. The new electronics centre consists of a symbiosis of laboratories, workshops, project rooms and development offices which covers the entire spectrum of electronics services from end to end. The centre represents a breeding ground for innovative developments in the field of electronics – from the initial concept through to the start of volume production.

Close proximity allows for rapid knowledge transfer

Bertrandt's electronics skills have been brought together in Ingolstadt to create an electronics centre which can efficiently meet the increasingly complex requirements placed on electronics systems in vehicles and promote the networking of resources and knowledge. The fact that the electronics specialists are now in close proximity to one another makes for faster communication and coordination processes. It also ensures that the expertise from the entire range of services is available to the individual disciplines, including the design and development of modular hardware and software solutions for test systems, testing, analysis and validation of individual modules and complete vehicles, cross-sectional functions, support and the development of vehicle derivatives.

In order to ensure that the electronics centre can meet the increasing demands of the market, a new building has been designed as its home. The layout of the building provides the ideal working conditions, with a central workshop area surrounded by laboratories, project rooms and development offices. In the new building, complex test systems are already being designed and constructed, comprehensive test scenarios are being implemented and networks for special vehicles, armoured vehicles and complete vehicle derivatives are being developed. The software and function development departments for Chassis, Powertrain, Integral Safety, Body and Infotainment will soon be moving in as well.

Developing test systems

Complex automated test systems run specific test sequences independently and evaluate the results around the clock. The test sequences can be repeated as often as necessary. In the electronics centre these test benches are designed, developed and constructed by specialists. Depending on customer requirements, a range of different components can be used, including modular systems developed by Bertrandt and tried-and-tested hardware and software solutions.

The majority of the test benches constructed in recent years are used for functional testing of control units for vehicle comfort and infotainment systems, which are highly complex and come in a wide range of different forms. As well as testing the functions themselves, the diagnostic abilities of the devices must also be evaluated. The process of testing end-to-end system functions represents a particular challenge. This is where the functions which the customers experience directly come under scrutiny, including the user and data entry interfaces for the driver, such as buttons and switches, and the visual and audible feedback from the vehicle (displays or loudspeakers).

As a result, totally new approaches are needed in the field of test system development. Among other things, Bertrandt uses robots to operate components and camera systems with complex image processing algorithms which analyse and verify the images displayed on combination and navigation displays.

Release testing of systems and components

Vehicle manufacturers and systems suppliers frequently outsource the testing of products and modules to independent laboratories. If the product passes the test successfully, the client will give the approval to release it for volume production. Bertrandt is one of the leading industry test providers in this area with its accredited and certified testing laboratory.

Release tests are primarily carried out on complex electronic control units and components in order to guarantee their quality and reliability throughout the life of the vehicle. The components are subjected to a series of tests which cover, among other things, their behaviour under extreme climate conditions, during voltage fluctuations in the vehicle electrical system, during misuse and under mechanical influences, such as vibrations or impacts. In addition, endurance tests are carried out to evaluate their functional behaviour under accelerated ageing (temperature profile).

The very latest technology is used in the tests, such as real-time systems, high-resolution measurement modules, rapid-scanning, multi-functional measurement systems, Bertrandt's own control and measurement modules and tools such as software for measurement and evaluation. Test systems are used for climate and temperature-related tests. In some cases Bertrandt develops these tests in-house and to meet the latest technical requirements of the relevant DIN ISO/VDA standards and customers' specifications.

Developing electrical/electronic systems for vehicle derivatives

Special vehicles, such as taxis, driving school and police cars and armoured vehicles for protecting people and objects, make up the majority of the derivative sector. The services offered by the Bertrandt electronics centre in Ingolstadt cover two areas. One of these is vehicle networks, including the development of electrical systems and functional definitions for control units, which allow special functions, such as taxi meters and police radio systems, to be implemented. The other area is the development of networked functions for different derivatives and functional descriptions for implementation by systems suppliers.

One of the most important tasks is to ensure that the products have the required level of quality and functionality. This includes comprehensive testing of wiring looms and functions – in prototype vehicles and on the networking board (laboratory test bench) – as well as the development of system wiring diagrams for special vehicles. Bertrandt also supplies wiring looms and equipment for the volume production of special vehicles, which are produced by the electronics centre.

Ready for the future

The increasing functional complexity of electronic components and systems and the reductions in development times demand a pragmatic, flexible approach to development without compromising on quality. Bertrandt's objective is to meet this and other future requirements, and the electronics centre in Ingolstadt represents the ideal platform for achieving this goal. ■

Stephanie Frieß, Ingolstadt

The seat of the future

Ingolstadt team develops a futuristic driver's seat

Seat concept designs from the "Audi", "VW" and "Mini" teams (from left).

What will drivers' seats look like in 2015?
A team of Bertrandt employees in Ingolstadt is in the process of investigating this question. As part of the project, the Ingolstadt site held a design competition last autumn for students from Munich with the title "Concept seat 2015". The teams of students impressed the panel of judges with a combination of highly innovative technological solutions and professional presentation skills.

The vision: Concept seat 2015

Alongside their day-to-day project work, the members of the Ingolstadt seat team have been taking part in forward-looking activities, such as designing a concept for a car seat for the year 2015. The young design engineers Nicholas Scherer and René Keipert have been working on this challenging task under the leadership of branch manager Erhard Dörr and the responsible teamleader Thomas Busch. With the involvement of some degree students, the aim is to design and construct a "human-friendly" seat which is ergonomically correct. The group is currently in the course of producing a functional model. "We have been working on the project since last summer," says René Keipert, explaining that the key concepts during the planning process were "light, functional and user-friendly".

The objectives of this internal, OEM-related project are to encourage and promote the skills of the next generation of engineers and to develop concepts which will indicate the possible appearance of a driver's seat in 2015 and the functions it will offer. "We are looking towards the future and taking two steps forward," says Dirk Zimmer, head of the vehicle interiors department.
This project gives Bertrandt the opportunity to demonstrate its development and product expertise, which would generally only be possible to a limited extent, because of the confidentiality required on customer projects. "Our aim is to make use of the latest trends and to get our ideas out into the market," says Zimmer. The team's last prestigious project of this kind was the "Ergo-Seat" which was completed in 2003. Bertrandt is also in discussions with customers about the project, in order to be able to take its innovative approach even further. The objective is to give the seat a futuristic appearance, but also to meet all the possible technical requirements.

The competition: Technical innovation required

Against this background, in October 2007 the "Concept seat 2015" competition was launched in collaboration with the University of Applied Sciences in Munich for students of the class of 2005 from the strategic design course. The task was to produce design studies with brand-specific ideas and concepts relating to the appearance and functionality of car seats. A total of five teams took part, representing the Mercedes, Mini, Audi, Volkswagen and Porsche brands.

Awards ceremony at Bertrandt in Ingolstadt.

Before beginning the design process, the students had to become familiar with the image of each manufacturer and adapt it to the potential circumstances in 2015. On this basis the students went on to create their designs, which were presented to the panel of judges and evaluated during the awards ceremony at Bertrandt's Ingolstadt site. The panel of judges consisted of the mayor of the city of Ingolstadt, Dr. Alfred Lehmann, Martin Leilich, former head of the seat development department at Audi AG and Rüdiger Müller, head of seat design at Audi AG. After the votes were counted the award went to the "Mercedes" team of Josef Petryszak and Helmut Jung, who received the most votes. The two students had produced two light-weight, breathable seat designs with multiple adjustment options. Their first design in particular aroused a great deal of interest. It consisted of a band of fabric stretched over a seat frame with sweeping lines. The band could be tensioned tightly or loosely to suit the driver's requirements and to make the seat more comfortable. The idea was highly innovative, but technically complex to implement, as René Keipert explained: "On the one hand it must be possible to adjust the tension of the fabric band to ensure that the seat is comfortable for different people. On the other hand, it is essential that the band does not tear in a crash." Despite this, in the judges' opinion the two students had produced the best combination of technical innovation, an attractive design and an interesting presentation and therefore were awarded the 2000 euro first prize.
Second place went to the "Volkswagen" team, which designed a "super sports seat" (Keipert) that almost completely surrounds the driver. The "Porsche" team was in third position with a sporty, dynamic, high-performance and high-quality seat design inspired by the image of the sports car manufacturer. These two designs particularly impressed the judges with their dynamic lines and technical details, such as an innovative side bolster adjustment system. "In this case the technical implementation was very good," said René Keipert. The "Audi" group, with its realistic designs, beat the "Mini" team into fourth place.

Positive response: Professional concepts

In retrospect all the participants felt that the competition and the event had been successful and productive. The audience was impressed in particular by the professional quality of the designs and by the technical solutions. ■

René Keipert, Ingolstadt
Michael Ziegler, Ehningen

Close to reality

Robots set new standards in vehicle exterior testing

Robots opening the door in the test cycle.

Industrial robots have recently been used in endurance testing at Bertrandt in Munich, in order to increase the efficiency of the tests. The robots form part of a newly developed test bench, which has increased the realism of the test sequences, in particular by integrating the vehicle electronics system.

Control units included in endurance testing

Safety, reliability and structural durability are key concepts for the automotive industry. As a result, the development process includes numerous endurance tests of individual vehicle components. These tests are time-consuming and costly, because they are often based on individual solutions.

In order to make the testing process more efficient, Bertrandt in Munich has developed innovative test benches for door endurance tests. These test benches use robots to perform the mechanical tasks in the test and have a universally programmable interface to the vehicle electronics system which has been developed by Bertrandt.

The use of robots has reduced the time needed to set up the test bench and the periods for which it is out of action. It also allows for highly realistic test sequences. The interface to the vehicle electronics system enables all the control units to be integrated into the endurance test. As a result, faults can be evaluated online and any failures or malfunctions can be identified much earlier than it was previously the case. In addition, it is possible to document faults in much more detail.

The fully automatic documentation function records all the faults and the relevant environmental conditions and sends regular reports by e-mail or text message to the operator of the test bench. Therefore, long down-times and the resulting high climate chamber costs have become a thing of the past.

Use of robots under extreme conditions

For a long time, it was not possible to use robots in exterior testing, as some of the tests were carried out under extreme climatic conditions, including temperatures as low as -30 °C and as high as +80 °C and humidity levels of up to 95 %, which are borderline conditions for the operation of robots. Bertrandt has developed its own special cooling system to ensure that the robots function correctly.

Fully automatic parameter set-up keeps maintenance time to a minimum

A further highlight of the new system is the ability to control the speed of the robots. This means that there is no need to spend long periods setting up the test bench parameters. In addition, the changes brought about in the test sample as a result of the extreme climate conditions can be accommodated.

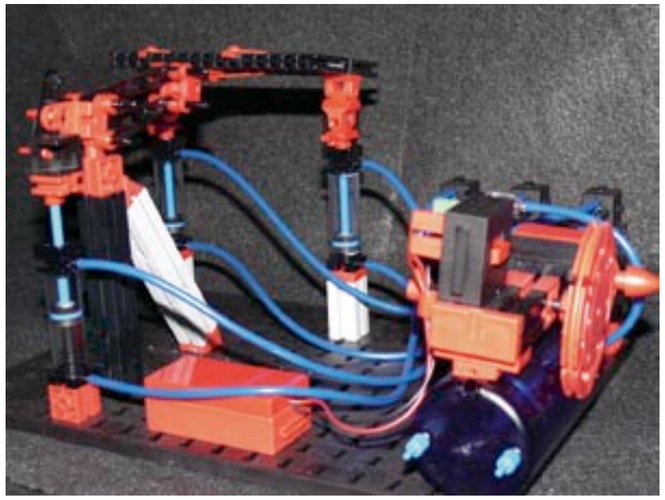
The project, which began with a dissertation entitled “Automating a Door Endurance Test using LabVIEW with the aid of the Vehicle Electronics System and an Articulated Robot”, is now the subject of a doctorate. This guarantees that the test bench will be developed further over the next few years to meet new requirements of car manufacturers.

Robots are now used for almost all exterior tests. In addition to the door endurance test, they are increasingly incorporated into vehicle interior testing as well. In order to ensure that the functional touch tests are as realistic as possible, a specially developed orthopaedic hand is employed. As a result, it is possible to carry out highly realistic tests of the glove compartment handle and the steering wheel height adjustment and the seat functions, among other things. ■

Philip Class, Jens Vogelpohl, Munich

Simulated truck transport

Design and creation of a three-axis test bench for transport simulation



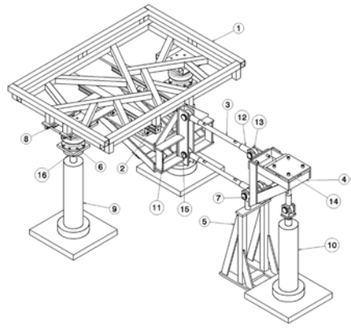
Transport simulations are an important aspect of product development and are growing in significance for the automotive industry. The gradual increase in the level of disassembly of vehicles, the use of more modern materials and the application of lightweight design principles are presenting new challenges for packaging units. This problem is particularly evident in the area of CKD (Completely-Knocked-Down). As a result of the use of disposable load carriers and increasing pressures on costs, transport simulations have become an essential element of the concept phase for Bertrandt.

From one axis to three

Dynamic transport simulations on servo-hydraulic test systems generally make use of only one axis, with the z-component being the predominant direction of travel. The measurement of acceleration over time and the more detailed consideration of the often complex responses of the load carrier have resulted in the development of a three-axis test bench. As part of a degree dissertation in the field of vibration, existing servo-hydraulic test systems were combined to produce a modular test bench. The objective was to activate a euro pallet of test samples using vibration signals in order to cause a translatory movement in the direction of the vertical z-axis and a rotational movement around the x-axis and the y-axis which are at right angles to the z-axis. This is intended to represent the rolling movements which occur during truck transport as realistically as possible.

Combining lightweight structures and optimised vibration behaviour

The signal used to activate the pallet was a real-time signal from a vehicle moving along a road. The components of the test bench shown were either purchased or constructed from scratch. The base plate is an aluminium framework designed on the basis of vibration-related asymmetries and networks of nodes which have a damping effect on one another. The result is a highly efficient lightweight structure with optimised vibration behaviour. The remaining open areas are filled with an aluminium sandwich panel.



Ideas finalised during the model phase

The process of creating the test bench was preceded by the model phase, during which all the ideas about the possible ways in which a test bench of this kind could function were finalised. Using a model kit from Fischertechnik, the degree student built a model of the test bench in order to investigate the extent to which the kinematic movements could be put into effect with only three servo-hydraulic cylinders.

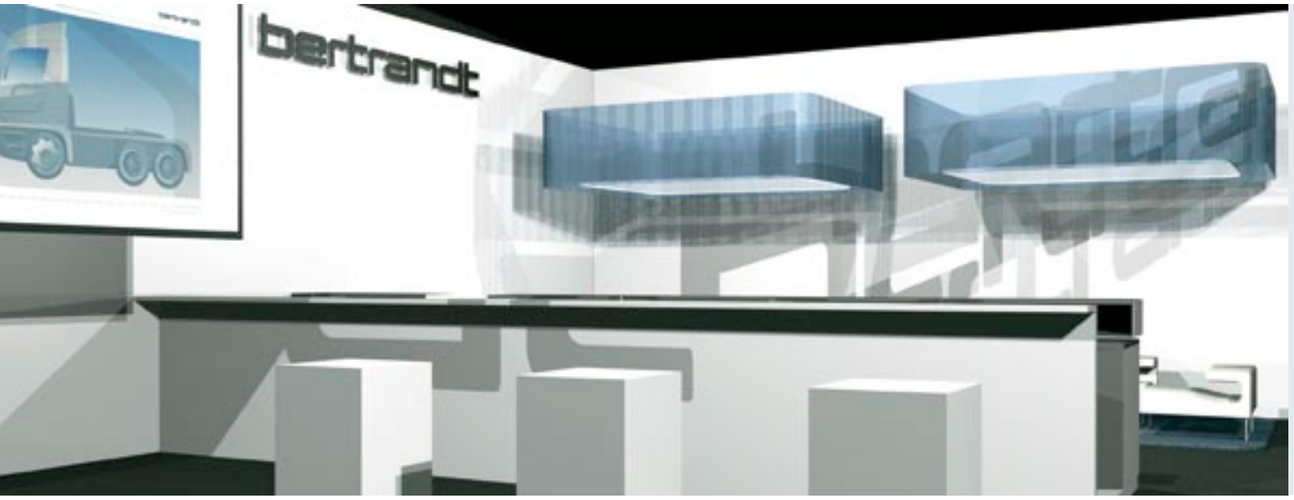
Simple and cost-effective

The benefits of the test bench include the modularity of the individual components, the speed with which it can be assembled and disassembled, and the option of using existing equipment. Although there is room for further improvement, the test bench as currently designed is a relatively simple and cost-effective method of conducting transport simulations. ■

Ioannis Fragos, Marc-Oliver Matthies, Ehningen

Premiere at the IAA Commercial Vehicles fair

Bertrandt at the IAA in Hanover



Communication | Information | Relaxation

From 25 September to 2 October Bertrandt presented its range of services in Hanover for the first time. Bertrandt Lounge in Hall 13, Stand C54: „Recharge your Batteries“.

Combining communication and technology

Bertrandt will be celebrated its first appearance at the fair, which this year had the theme of “Commercial vehicles: On the move for everyone”. “We wanted to make our many years of experience available to the commercial vehicle industry and offer our customers a platform for positive discussions,” explains Project Leader Miriam Sämann. The exhibition stand, which had the atmosphere of a comfortable lounge, provided the ideal setting for an attractive combination of Communications and Technology. Three times each day, Specialists and Managers presented a portrait of the company and its range of services.

Road safety exhibit

Bertrandt put its electronics expertise on display in the form of an exhibit showing the development of functions for Driver Assistance Systems. This is a demonstration version of an optical road sign recognition system. The background to the system is the increasing amount of traffic on the roads, which the automotive industry aims to compensate for by developing driver assistance systems. The objective is to reduce the driver’s workload and improve road safety. As these systems grow more complex, the need for a complete evaluation and interpretation of the vehicle’s surroundings is becoming increasingly obvious. One aspect of this is the recognition of road signs in the context of the vehicle’s current situation. Bertrandt has developed a prototype optical road sign recognition system which identifies road signs statically and dynamically on the basis of a colour camera image, classifies them using neuron networks and displays them on an existing navigation screen.

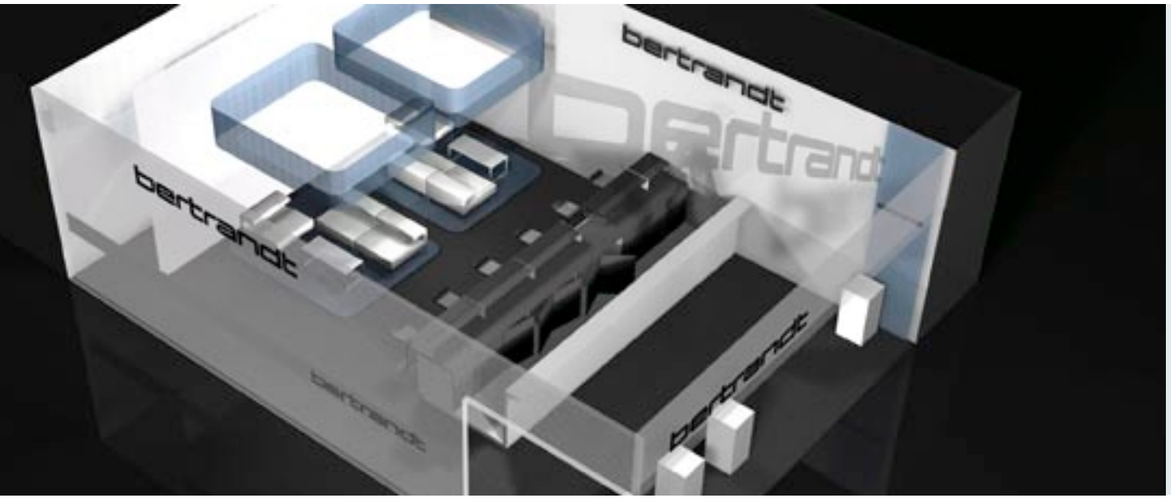
Recruitment platform

The exhibit attracted attention not only from potential customers, but also from potential employees, such as graduates, prospective engineers and other professionals. Bertrandt was aiming not only to acquire new customers at the industry fair, but also to recruit new employees. “We were happy to spend time with visitors who are interested in the company,” says Markus Chrustowski from the HR department. This major fair is certain to provide Bertrandt with the ideal platform for recruiting future employees. ■

Michael Ziegler, Ehningen

IZB 2008

The developments of tomorrow on show



The International Suppliers Fair (IZB) in Wolfsburg is often referred to as the meeting place for decision-makers. For this reason Bertrandt, a long-term partner of the automotive and aerospace industries, was exhibiting its services at IZB, the second largest specialist automotive fair in the world. From 29 to 31 October, the development service provider was putting on display electronics and testing systems especially designed for IZB 2008.

Communication in the lounge

With 609 exhibitors from 21 countries and 42,000 visitors, IZB is one of the most important international industry fairs. At the exhibition, where all the facilities are within easy reach, all the latest products and developments from the automotive subcontracting industry were on show under one roof. Bertrandt's innovative exhibition stand had the atmosphere of a lounge and visitors were invited to talk to contacts from Bertrandt's specialist departments. The company showed its eye-catching exhibits to prompt discussions about the themes and requirements of the future.

A fascination with vehicle safety

Bertrandt was using an exhibit especially designed for IZB 2008 to demonstrate its electronics expertise in different areas of performance. Various subjects, ranging from end-to-end functional system development and hardware development through to universal measurement and testing platforms, have been combined to create one complete system. Using a simulator, the electronics team from Bertrandt's Wolfsburg site presented a driver assistance system which is able to calculate how far away obstacles and other road users are. A range of sensors which are tested on a universal measurement platform are used to detect environmental influences. "This platform is also able to simulate the sensor data and to expose the driver assistance system to virtual external influences," says department manager Matthias Drewitz. The project is supported by a comprehensive project management system which ensures that the latest design guidelines are followed.

Robots replace people

The Wolfsburg testing team is put a robotics application on display. A test structure was used to present a realistic example of the everyday use of a vehicle cockpit. This involves a robot simulating typical movements made by a person, taking into account a number of different variables. The use of this technology allows the uncertainty factor represented by human involvement to be eliminated from the test. "From October on, we will be extending our range of services to include the use of robots in functional endurance tests and touch tests," explains Sven Neumann, head of the interior testing team.

An active role in the job market

Representatives of the technical and human resources departments were speaking about the exciting career opportunities at Bertrandt as part of the IZB job market day on Thursday 30 October. Bertrandt also presented degree dissertations and student assignments which have been completed by Bertrandt employees in recent years to an audience of interested students. ■

Michael Ziegler, Ehningen

Additional benefits for customers

Bertrandt opens new facilities in Wolfsburg

Wolfsburg Bertrandt-Managers in front of the new testing warehouse: Michael Schulz, Jan-Peter Scheele and Thomas Martens (from left).

The Bertrandt site in Wolfsburg gave visitors a glimpse behind the scenes at the official opening of its new testing and unheated warehouse facilities on 10 July 2008. Customers, media representatives and guests from the worlds of politics and business gained a good impression of the new extension.

Increasing complexity makes expansion necessary

Against the background of increasing requirements and complex projects, Bertrandt in Wolfsburg has broadened to its range of services. A 2,800-square metre extension housing offices and workshops has been added to the existing building and a test track for vehicle quality assurance and approval has been constructed.

Wide range of services

The testing areas will offer services relating to component and electronics testing, vehicle safety and structural durability. In addition, the new testing workshop has one of the largest accredited environmental simulation facilities in the region. ■

Carmen Braun, Wolfsburg

Bertrandt in Wolfsburg

The figures speak for themselves. Over the course of the last 13 years the Bertrandt Wolfsburg site has become a high-quality development partner of the automotive industry. The 600 employees working in 10,000 square metres of office and workshop space have a particularly close relationship with Volkswagen AG and its suppliers.
The services which the site has to offer cover all aspects of module and vehicle development. In order to be able to meet its customers' challenging requirements in future, Bertrandt Wolfsburg has been investing in staff and resources over recent years. In addition, the employees at the site are involved in the new training course for technical product designers, which will help to ensure that sufficient designers are available in future.

In the fast lane with Bertrandt

Automotive Days at the Hockenheimring

A day at the Hockenheimring: Technical expertise on show.

With high speed to Bertrandt!

The first “Automotive Days” were held on 17 and 18 April at the Hockenheimring, providing an unparalleled experience for Bertrandt job applicants.

Exciting moments on the track

A few simple words which call to mind thousands of spectacular images: the Hockenheimring in Baden-Württemberg. As one of most famous racing circuits in the world, the Formula 1 track with all its attractions provided a breathtaking backdrop for the first Bertrandt AG “Automotive Days” on the theme of electronics and powertrains.

Engineers with petrol in their blood

Because Bertrandt is constantly searching for committed engineers with petrol running through their veins, the company decided to invite a total of 50 applicants to spend a day at the Hockenheimring, with the support of its electronics and powertrain departments. The candidates were expected to demonstrate their technical expertise and total commitment in group exercises and individual interviews.

Throughout the event the participants had the opportunity to speak to managers from a number of Bertrandt’s sites and departments. The highlights of the event were interesting presentations from the motoring world.

The adrenaline flows behind the wheel

On the evening of 17 April all the participants had the chance to take standard production cars out onto the racing track. They all underwent a driver training session with experienced instructors on a specially hired small-scale course. As well as experiencing the pleasure of driving, the applicants and employees were able to get a feel for the world of racing on the track, in the paddock and on the south stand.

Training in the recovery simulator and a visit to the most carefully monitored room on the circuit, known as “race control”, completed the enjoyable evening programme.

Bertrandt wins at high speed

The unmistakable atmosphere of the Hockenheimring, combined with the interesting technical topics under discussion ensured that the event was a complete success. The positive response from the participants clearly showed that Bertrandt had succeeded in impressing them with the combination of speed and adrenaline on offer. ■

Melanie Schulze, Ehningen

“For us 2015 is tomorrow”

Third Capital Market Day in Ehningen

The review of the first half-year 2007/2008 at the third “Capital Market Day” held in the company headquarters in Ehningen on 8 May produced positive results. Chairman of the Board Dietmar Bichler presented an audience of analysts, bank representatives and journalists with an impressive set of figures and introduced two distinguished experts on the economy as guest speakers.

Turnover rises to 199.9 million euros

Bertrandt Chairman Dietmar Bichler opened the event by presenting the group results for the first half of the financial year 2007/2008 to the 50 attendees. Bertrandt’s turnover increased by 26.2 percent over the previous year to 199.9 million Euros. EBIT grew by 71.4 percent to 22 million euros. Dietmar Bichler is expecting equally good figures in future. Despite the subprime crisis, he sees positive opportunities ahead for the Automotive Industry and therefore also for the Bertrandt group: “We are in a good strategic position and our size and financial stability gives us advantages on the market.”

“For us 2015 is tomorrow”

Innovation was the central concept of this year’s “Capital Market Day”. “Only innovative manufacturers can look forward to a successful future,” said Horst Binnig, chairman of the board of KS Aluminium Technologie AG and member of the supervisory board of Bertrandt AG, who explained to the audience the importance of new developments for the automotive industry. “The pressure on subcontractors of the automotive industry is constantly growing. If companies in a high-wage country like Germany really want to survive, then they have to promote innovation.” Horst Binnig emphasised that new developments nowadays have a shorter life than ever before. “For us 2015 is tomorrow,” he explained.

Well-established recruiting structures

In order to be able to respond to these conditions, it is increasingly important for companies to have competent and well-qualified staff. Dietmar Bichler highlighted the fact that Bertrandt is one step ahead in this area. Cooperation with a wide range of universities over a number of years and well-established recruiting structures have put the company in an excellent position. “Despite the current shortage of engineers, we have recruited a number of good people.”

Porsche values collaboration

All this will have been music to the ears of Holger P. Härter, CFO and deputy chairman of the board of Porsche Automobil Holding SE and Dr. Ing. h.c. F. Porsche AG. He explained the continuing good results of the sports car manufacturer among other things in terms of reliable collaboration with suppliers, including Bertrandt AG. “For us, Bertrandt is a strategically important partner.“ ■

Michael Ziegler, Ehningen

Corporate Calendar

03./04.11.2008	bonding, Berlin (Bertrandt Services)
04.11.2008	meet@h_da, University of Applied Sciences Darmstadt
05.11.2008	meet@fh-trier
04.-06.11.2008	driveIT – software for the vehicles of tomorrow, Stuttgart
05.11.2008	HOKO, University of Applied Sciences Munich
06.11.2008	ZWIK, Zwickau
11.11.2008	Work experience forum, University of Applied Sciences Würzburg-Schweinfurt
11.11.2008	JOBcon IT, Karlsruhe (Bertrandt Services)
11.-14.11.2008	Recruiting forum electronica 2008, Munich
12.11.2008	Company day, Bonn
12./13.11.2008	Konaktiva Dortmund (Bertrandt Services)
14.11.2008	VDI nachrichten recruiting day, Ludwigsburg
14./15.11.2008	German-French forum, Strasbourg
18.11.2008	Industry day, Steinfurt campus, University of Applied Sciences Münster
18./19.11.2008	Career days, University of Applied Sciences Ravensburg-Weingarten
19./20.11.2008	Graduate congress Cologne
20.11.2008	Recruiting fair Munich (Bertrandt Services)
20.11.2008	Contact ING, University of Applied Sciences Nuremberg
25./26.11.2008	bonding, Braunschweig
26.11.2008	meet@hs-fulda (Bertrandt Services)
26.11.2008	Recruiting fair, University of Applied Sciences Offenburg
26.-27.11.2008	Simulation and calculation in vehicle manufacturing, Baden-Baden
26.-27.11.2008	FlexRay product day, Fellbach
01.-03.12.2008	bonding, Aachen
02.12.2008	VDI, Munich
03.12.2008	VHK forum IT and mechanical engineering for the automotive industry, Munich
04.12.2008	Annual results press conference, Stuttgart
04.12.2008	Analysts conference, Frankfurt am Main
04.12.2008	CampusX, University of Applied Sciences Pforzheim
08./09.12.2008	bonding, Hamburg
11.12.2008	JOBcon Classic, Frankfurt (Bertrandt Services)
20.01.2009	meet@fh-giessen-friedberg
22.01.2009	meet@htw-dresden
27./28. 01.2009	9th international CAR symposium, Bochum
27./28. 01.2009	bonding, Kaiserslautern
February 2009	Quarterly report for the period up to 31.12.2008
10.-11.02.2009	Euroforum electronics systems in cars, Munich
18.02.2009	Annual General Meeting, Sindelfingen
18.02.2009	JOBcon Engineering, Frankfurt
24.-25.03.2009	8th international Stuttgart symposium for automotive and engine technology
25.-26-03.2009	VDI – plastics in vehicles, Mannheim
08.04.2009	Soest careers day, South Westphalia University of Applied Sciences, Soest
21.-23.04.2009	Connecticum 2009, Berlin
28.04.2009	meet@fh-frankfurt
30.04.2009	meet@fh-aachen
05.05.2009	meet@fh-köln
06.05.2009	CONTACT 2009, University of Applied Sciences Ingolstadt
05./06.05.2009	bonding, Dresden
12./13.05.2009	bonding, Stuttgart
May 2009	Quarterly report for the period up to 31.03.2009
19.05.2009	meet@fh-hannover, Hanover
15.-17.06.2009	bonding, Karlsruhe
22.-23.06-2009	bonding, Bochum (Bertrandt Services)
07./08.07.2009	bonding, Erlangen
August 2009	Quarterly report for the period up to 30.06.2009

Bertrandt in Brief

+++ In the slipstream of Formula 1
The Hockenheim ring was the scene of thrilling action during the "Formula Student Germany 2008" design competition. This year, 77 university teams demonstrated the racing cars they had designed in front oft a panel of judges, which included two Bertrandt employees. The cars developed by the prospective engineers made for exciting racing, but speed and driving skills were not the only criteria. The teams had to demonstrate that they met the complete package of technical and financial requirements. During the "Formula Student Germany" project, Bertrandt provided support for teams from the Universities of Applied Sciences in Braunschweig-Wolfenbüttel and Hamburg and from the University of Cooperative Education in Ravensburg/Friedrichshafen. +++

+++ "The human face of success"
In order to promote the Bertrandt Services subsidiary (which came into operation in February 2007) amongst potential customers and job applicants, a communications campaign was launched in May of this year with the slogan "The human face of success". A range of advertising measures will be used to attract the attention of passers-by in airports, universities and public transport stations. +++

+++ New design studio
In order to be able to handle future orders rapidly and successfully, the Bertrandt site in Cologne modernised its design studio in the space of only six weeks. The group invested in another surface plate and moved into a building with a floor area of 450 m². The move has already brought beneficial results. Following the first few weeks of qualitatitive judgement and a large number of customer contacts, the Cologne group had received entirely positive feedback. +++

+++ Annual Euroforum conference
Bertrandt exhibited at this year's Euroforum conference on the subject of electronics systems in cars, which took place in the Hotel Sofitel in Munich on 6 and 7 February. The connectivity tester that the company had developed for a client attracted a great deal of interest. The device is used in a production environment to identify whether mobile phones are compatible with infotainment systems. +++

+++ Donation
Bertrandt is supporting the Technical College in Kaiserslautern. The company's support takes the form of a donation from its site in Rüsselsheim towards a training course for state-certified technicians in body work and vehicle manufacturing. A four-figure sum was given to the college on 20 February 2008 and will be used to purchase additional software licences. +++

+++ Girls in a man's world
The Technikum in Ehningen and the Rüsselsheim site once again played an active part in the nationwide "Girls' Day – Future Prospects for Girls" initiative. On 24 April, girls with an interest in Engineering had the opportunity to find out more about technical jobs, which have traditionally been a male domain. +++

+++ Bertrandt enhances its image
Bertrandt Services exhibited at the Hanover Fair this year from 21 to 25 April, with the aim of recruiting Technical Specialists and Managers. Around 5,100 exhibitors at the fair presented the latest trends and innovations over an area of 170,000 square metres.
In contrast, at the beginning of the month, the focus was on customer relationships at the Aircraft Interiors Expo in Hamburg (1 to 3 April). At this international exhibition exclusively devoted to the interior design of aircraft cabins, Bertrandt shared a stand with its partner Aeroconseil. +++

+++ Quarterly report for the period ending 30. June 2008
The Bertrandt Group was able to further consolidate its position in the market for Development Services during the 3rd fiscal quarter of 2007/2008. Bertrandt's turnover of 316.3 million Euros was 28.2 percent up on the previous year. The company's EBIT was 35.5 million Euros and Earnings after Taxes amounted to 25.1 million euros. +++

Stephan Vogt

"For us the focus is on people"

Site Manager and Technical Director Stephan Vogt has been at the helm of the Bertrandt site in Cologne for nine years. As part of his job, the mechanical engineer meets a wide range of different people every day. The same goes for his free time, which he spends travelling and learning about other cultures. The factor which links his interests and his job is the ability to think outside the box.

Stephan Vogt's first year as manager of the Cologne site could hardly have gone better. Only a few months after he took the job in 1999, Bertrandt was given the coveted Tier 1 Supplier status by Ford. This was a major success for the Cologne site and confirmation that it had been providing an excellent service over a number of years.
Stephan Vogt's career has been similarly successful. After completing his degree at the University of Applied Sciences in Osnabrück, he cut his professional teeth at an engineering company in Lower Saxony. In 1990 he joined Bertrandt in Stuttgart as a Design Engineer. He moved to the Cologne site in 1993 and took on the position of Automotive Project Leader. After three years he was promoted to manager of the Body-in-White and Component Development department and was able to acquire important customers, such as Delphi Automotive, LEAR Corporation, Huf and Kiekert for Bertrandt. Vogt's understanding of people was a crucial factor. "One of my strengths is my ability to relate to employees and customers," he explains. This is particularly important in the field of Development Services: "For us the focus is on people and their expertise. This is at the heart of everything we do."
It's no surprise, that Vogt, now 47, constantly encourages networking amongst the individual departments at his site. "We can work more efficiently by making use of synergies across different teams" is his motto. This philosophy has proved its worth over recent years. Today, Cologne is one of the largest development sites in the Bertrandt network. More than 500 specialists support customers in developing innovative products to meet the market requirements of the future.

> "We are proud of the fact that we can handle complex projects of this kind."

The fact that the staff at the Cologne site not only work hard but also produce high-quality results is demonstrated by the increasingly complex orders placed by Ford. The main challenge which the site is currently facing is the development of a model upgrade. More than 70 engineers and technicians are currently working on the vehicle to ensure the successful start of volume production. "We are proud of the fact that we can handle complex projects of this kind," says Vogt, whose aim is to intensify the relationship with Ford even further in future. His fellow director Michael Lücke is a valuable partner. The two directors manage the site jointly and work together to ensure its success. Lücke is primarily responsible for Engineering Services, Chassis Development and Testing, while Vogt focuses on Interiors, Body-in-White and Electronics. "We function as a team and we're in constant contact," emphasises Vogt. "Each of us benefits from the strengths of the other." Ever since he was at school, Vogt's strengths have been in technical and scientific fields. "Technology has always inspired me," he explains. It is important to him to help people throughout the world to become involved in technological developments. "There are too many differences," says Vogt, who is a father of two and enjoys immersing himself in other countries and cultures. He has learnt a lot during his travels around the world, but has also discovered the advantages of life in Germany. "I have learnt to appreciate the fundamental values of life and now I complain a lot less." This positive attitude has also characterised his career.
Given his affinity for other countries, he was the ideal candidate to take over responsibility for Bertrandt's Dunton site in 2005. He enjoys spending time in the UK. "I like the country and the people and feel very much at home in England." This also applies to the underwater world, as Stephan Vogt has a passion for diving. For him the attractions of adventures below the surface of the water include moving "in a three-dimensional space" and discovering "a different world". From 1980 to 1992 he was a rescue diver and lifeguard in the German Lifeguards' Association and was responsible for the safety of a large number of people, in the same way as in his day-to-day work.
His major objectives include overcoming future challenges and ensuring the company's success. His wife Gudrun and his two daughters Lina and Pia give him the strength to achieve his goals. His principles of reliability, honesty and commitment characterise both his private and his working life. "You always meet people more than once in life," says Stephan Vogt and after a short pause he adds the most important part of his guiding principle: "But you can only really meet people when you know them." This is what 22 years of professional experience have taught him. ■

Michael Ziegler, Ehningen

Masthead

Publisher:
Bertrandt*magazine* is published by
Bertrandt AG
Birkensee 1
D-71139 Ehningen
Phone +49 7034 656-0
Fax +49 7034 656-4100
Internet: www.bertrandt.com
E-Mail: info@bertrandt.com

Editorial Responsibility:
Anja Schauser

Editorial of this Issue:
Claudia Conrad-Hofmann, Stephanie Frieß, Julia Gärtner, Vera Lamprecht, Elisabeth Medele, Hartmut Mezger, Angel Moran, Melanie Schulze, Kerstin Thielen.

Layout:
Hartmut Mezger
Bertrandt Technikum GmbH

Editorial Office:
Bertrandt AG
Anja Schauser
Phone +49 7034 656-4037
Fax +49 7034 656-4090
E-Mail: anja.schauser@de.bertrandt.com

With kind permission of
the business partners mentioned in this issue.

Production:
Druckerei Mack GmbH
Schönaich

CI-410-11.08-A

Bertrandt *29 Offices in Europe and the USA*

Germany

Ehningen
Bertrandt AG – Head office
Birkensee 1
D-71139 Ehningen
Phone +49 7034 656-0
Fax +49 7034 656-4100
info@bertrandt.com

Altenburg
Mühlpforte 2
D-04600 Altenburg
Phone +49 3447 8900-00
Fax +49 3447 8900-10
altenburg@de.bertrandt.com

Berlin
Bertrandt Services GmbH
Rosenstraße 2
D-10178 Berlin
Phone +49 30 243102-186
Fax +49 30 243102-22
berlin@bertrandt-services.com

Bielefeld
Bertrandt Services GmbH
Niederwall 47
D-33602 Bielefeld
Phone +49 521 923970-00
Fax +49 521 923970-11
bielefeld@bertrandt-services.com

Bremen
Hanna-Kunath-Straße 4
D-28199 Bremen
Phone +49 421 897614-60
Fax +49 421 897614-69
bremen@de.bertrandt.com

Bretzfeld
ZR Automotive
Karosserie- und
Prototypenbau
Moosbachstraße 8
D-74626
Bretzfeld-Schwabbach
Phone +49 7946 9105-0
Fax +49 7946 9105-120
bretzfeld@de.bertrandt.com

Dortmund
Bertrandt Services GmbH
Martin-Schmeißer-Weg 11
D-44227 Dortmund
Phone +49 231 725 198-0
Fax +49 231 725 198-69
dortmund@bertrandt-services.com

Düsseldorf
Bertrandt Services GmbH
Prinzenallee 9
D-40549 Düsseldorf
Phone +49 211 520 6577-0
Fax +49 211 520 6577-99
duesseldorf@bertrandt-services.com

Ehningen
Bertrandt Projektgesellschaft
Birkensee 1
D-71139 Ehningen
Phone +49 7034 656-0
Fax +49 7034 656-8700
bpg@de.bertrandt.com

Ehningen
Technikum
Birkensee 1
D-71139 Ehningen
Phone +49 7034 656-5000
Fax +49 7034 656-5100
ehningen@de.bertrandt.com

Frankfurt
Bertrandt Services GmbH
Im Weiherfeld 1
D-65462
Ginsheim-Gustavsburg
Phone +49 6134 2566-700
Fax +49 6134 2566-799
frankfurt@bertrandt-services.com

Freiburg
Bertrandt Services GmbH
Jechtinger Straße 11
D-79111 Freiburg
Phone +49 761 888 572-0
Fax: +49 761 888 572-13
freiburg@bertrandt-services.com

Garching
Dieselstraße 16
D-85748
Garching-Hochbrück
Phone +49 89 316089-0
Fax +49 89 316089-6152
garching@de.bertrandt.com

Hamburg
Blohmstraße 10
D-21079 Hamburg
Phone +49 40 7975129-0
Fax +49 40 7975129-2100
hamburg@de.bertrandt.com

Hamburg
Bertrandt Services GmbH
Blohmstraße 10
D-21079 Hamburg
Phone +49 40 7975 129-2800
Fax +49 40 7975 129-2810
hamburg@bertrandt-services.com

Heilbronn
Bertrandt Services GmbH
Friedrich-Gauss-Straße 5
D-74172 Neckarsulm
Phone +49 7132 386-400
Fax +49 7132 386-410
heilbronn@bertrandt-services.com

Ingolstadt
Lilienthalstraße 50-52
D-85080 Gaimersheim
Phone +49 8458 3407-0
Fax +49 8458 3407-111
ingolstadt@de.bertrandt.com

Karlsruhe
Bertrandt Services GmbH
Emmy-Noether-Straße 17
D-76131 Karlsruhe
Phone +49 721 627 3699-0
Fax +49 721 627 3699-1
karlsruhe@bertrandt-services.com

Cologne
Oskar-Schindler-Straße 10
D-50769 Köln-Feldkassel
Phone +49 221 7022-0
Fax +49 221 7022-100
koeln@de.bertrandt.com

Cologne
Bertrandt Services GmbH
Burg Hemmersbach
Parkstraße 24
D-50169 Kerpen
Phone +49 2273 5660-400
Fax +49 2273 5660-409
E-Mail: koeln@bertrandt-services.com

Mannheim
Bertrandt Services GmbH
Augustaanlage 18
D-68165 Mannheim
Phone +49 621 432707-0
Fax +49 621 432707-55
E-Mail: mannheim@
bertrandt-services.com

Munich
Anton-Ditt-Bogen 16
D-80939 München
Phone +49 89 316089-0
Fax +49 89 316089-121
muenchen@de.bertrandt.com

Munich
Bertrandt Services GmbH
Leopoldstraße 32
D-80802 München
Phone +49 89 120 2127-0
Fax +49 89 120 2127-30
muenchen@bertrandt-services.com

Neckarsulm
Friedrich-Gauß-Straße 5
D-74172 Neckarsulm
Phone +49 7132 386-0
Fax +49 7132 386-119
neckarsulm@de.bertrandt.com

Nürnberg
Bertrandt Services GmbH
Pretzfelder Str. 13-15
D-90425 Nürnberg
Phone +49 911 350644-90
Fax +49 911 350644-999
nuernberg@bertrandt-services.com

Regensburg
Osterhofener Straße 12
D-93055 Regensburg
Phone +49 89 316089-0
Fax +49 89 316089-5001
regensburg@de.bertrandt.com

Rüsselsheim
Im Weiherfeld 1
D-65462
Ginsheim-Gustavsburg
Phone +49 6134 2566-0
Fax +49 6134 2566-100
ruesselsheim@de.bertrandt.com

Stadthagen
Erlenweg 6
D-31715 Meerbeck
Phone +49 5721 9274-50
Fax +49 5721 9274-51
stadthagen@de.bertrandt.com

Stuttgart
Bertrandt Services GmbH
Birkensee 1
D-71139 Ehningen
Phone +49 7034 656-4600
Fax +49 7034 656-4699
stuttgart@bertrandt-services.com

Ulm
Bertrandt Services GmbH
Edisonallee 7
D 89231 Neu-Ulm
Phone +49 731 715783-00
Fax +49 731 715783-20
ulm@bertrandt-services.com

Wolfsburg
Krümke 1
D-38479 Tappenbeck
Phone +49 5366 9611-0
Fax +49 5366 9611-100
wolfsburg@de.bertrandt.com

France

Paris
Burospace, Bâtiment 10
Route de Gisy, B.P. 35
F-91572 Bièvres
Phone +33 1 69351505
Fax +33 1 69351506
paris@fr.bertrandt.com

Sochaux
Technoland
364, rue Armand Japy
F-25461 Etupes Cedex
Phone +33 3 81993500
Fax +33 3 81993501
sochaux@fr.bertrandt.com

Great Britain

Dunton
Unit 34 Hornsby Square,
Southfields
Industrial Park, Laindon
Basildon
GB Essex SS 15 6SD
Phone +44 1268 564 300
Fax +44 1268 564 301
dunton@uk.bertrandt.com

Sweden

Trollhättan
Nohabgatan 12e
S-46153 Trollhättan
Phone +46 520 4865-00
Fax +46 520 4865-01
trollhattan@se.bertrandt.com

Spain

Barcelona
Poligono Industrial Can
Comelles Sud
C/Gresol,1 - Ap. Correos 183
ES 08292 Barcelona
Esparreguera
Phone +34 93 777 87-00
Fax +34 93 777 87-13
barcelona@es.bertrandt.com

USA

Detroit
1775 W. Hamlin Road
Rochester Hills, MI 48309,
USA
Phone +1 248 598 5100
Fax +1 248 598 5106
detroit@us.bertrandt.com